SHIELDED DEVICE CONTAINMENT VESSEL

BACKGROUND

[0001] The present invention relates to a shielded device containment vessel for storing, transporting and detonating an explosive device and method of operating the same.

[0002] Bomb containment vessels are used for transporting and storing explosives, as well as containing an explosion. Typically, containment vessels are spherical or rectangular units having an external shell and a series of reinforcements and shock absorbing material between the shells. Containment vessels contain and absorb an explosion, accidental or intentional, to prevent damage to surrounding persons, environment, or structures. However, if radioactive explosives are stored or detonated within the containment vessel, the containment vessel does not prevent dispersal of radiation from the vessel. Thus, the containment vessel provides no protection to surrounding persons, environment, or structures from radiation exposure.

SUMMARY

[0003] In one embodiment, the invention provides a radiation shield including a plurality of panels formed of a radiation shielding material. The panels are shaped to complement a contour of a vessel and the panels are arranged proximate a portion of the vessel. A plurality of seam plates are positioned along a seam between adjacent panels and each seam plate overlaps adjacent panels.

[0004] In another embodiment, the invention provides a device containment apparatus comprising a vessel for storing a radioactive explosive device. The vessel includes an outer wall defining an interior area. A shield formed of radiation shielding material is positioned adjacent the vessel for minimizing dispersal of radioactive material from the interior area of the vessel.

[0005] In yet another embodiment, the invention provides a device containment apparatus for storing an explosive device and minimizing dispersal of radioactive material. The device containment apparatus includes a vessel including an outer wall defining an interior area, an opening through the outer wall for accessing the interior area, and a door providing access to the interior area of the vessel. A radiation shield formed of a radiation shielding material is positioned adjacent to a portion of the vessel.

[0006] In another embodiment the invention provides a method of using a device containment vessel to reduce exposure to radioactive material. The method includes providing a device containment vessel having an outer wall defining an interior area, an opening through the outer wall for accessing the interior area, and a door providing access to the interior are of the vessel. The method further includes positioning a shield adjacent the outer wall of the vessel, the shield being formed of a radiation shielding material, and placing an explosive device containing radioactive material in the interior area of the device containment vessel wherein the shield minimizes dispersal of radiation from the explosive device.

[0007] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a perspective view of one embodiment of a device containment apparatus embodying the invention.

[0009] Figs. 2-5 are perspective views of a partial assembly of the device containment apparatus of Fig. 1.

[0010] Fig. 6 is a section view of the radiation shield taken along line 6--6 of Fig. 2.

[0011] Fig. 7 is a perspective view of another embodiment of a device containment apparatus embodying the invention.

[0012] Fig. 8 is a perspective view of a partial assembly of the device containment apparatus of Fig. 6, showing a plate member.

[0013] Fig. 9 is a perspective view of a partial assembly of the device containment apparatus of Fig. 6, showing a plurality of plate members.

[0014] Fig. 10 is an end view of a device containment apparatus illustrating an internal radiation shield.

[0015] Fig. 11 is a section view of the device containment apparatus of Fig. 10 taken along line 11--11.

[0016] Fig. 12 is a perspective view of another embodiment of the device containment apparatus including a supplemental radiation shield.

[0017] Fig. 13 is a perspective view of another embodiment of the device containment apparatus including a supplemental radiation shield.

[0018] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings.

DETAILED DESCRIPTION

[0019] Figs. 1-5 illustrate a shielded containment system 20 according to one embodiment of the present invention. The shielded containment system 20 is especially suitable for use in the safe disposal and transportation of hazardous materials, including explosive devices (e.g., bombs) and materials, toxic materials, poisonous materials, radioactive materials, biological agents, and chemical agents, and objects having or expected of having one or more such hazardous materials. In a preferred embodiment, the shielded containment system 20 is used for transporting, storing, and/or detonating explosive radioactive materials.

[0020] The shielded containment system 20 includes a device containment vessel 24 and a radiation shielding system 26. The containment vessel 24 includes an outer wall 28 (Fig. 2), which at least partially encloses an interior area 32 for receiving explosive devices or materials. In the illustrated embodiment, the containment vessel 24 has a substantially spherical shape. The containment vessel 24 includes an opening 36 through the outer wall 28 for accessing the interior area 32 and a door frame 40, which substantially surrounds the opening 36. The door frame 40 supports a door 44 for movement relative to the door frame 40 between an open position (Fig. 1), in which the door 44 is moved away from or out of the opening 36, and a closed position (Fig. 5), preventing access to the interior area 32 through the opening 36. In one embodiment, the containment vessel 24 includes a latch for securing the door 44 in the closed position and a lock to further secure the door 44 in the closed position and to prevent or limit unauthorized access to the interior area 32. One example of a containment vessel used in the present invention is the Model 42-SCS manufactured by Nabco, Inc. (Pittsburgh, Pennsylvania).

[0021] In the illustrated embodiment, the containment vessel 24 is supported by and mounted to a support frame 48 that includes a base 52. Portions of the containment vessel 24 and the radiation shielding system 26 are coupled to and supported by the base 52, and in the illustrated embodiment the underside or bottom portion 56 of the containment vessel 24 is coupled to the base 52 by mounting brackets 54 (Figs. 2 and 3). The support frame 48 supports the containment vessel 24 in an elevated position above the ground or the floor so that a hand cart, dolly, forklift, or other carrier may more easily lift the containment vessel 24 off of the ground or the floor and move the containment vessel 24 from a first location to a

second, remote location. In these embodiments, the support frame 48 may provide openings for receiving portions of a hand cart, dolly, forklift, or other carrier (described below) to facilitate movement of the containment vessel 24.

[0022] In another embodiment, the support frame 48 includes a number of wheels or rollers connected to the support frame 48 to facilitate movement of the containment vessel 24 between locations. For example, the support frame 48 may be structured as a trailer so that an operator or a carrier can transport the containment vessel 24 more easily between locations. In some embodiments, the containment vessel 24 may include a dedicated carrier or other non-dedicated carriers may be operable to move the containment vessel 24.

[0023] As shown in Figs. 1 and 2, the radiation shielding system 26 provides a barrier to prevent or minimize dispersal of radiation from radioactive materials stored or detonated within the containment vessel 24 to the surrounding environment In the illustrated embodiment, the radiation shielding system 26 includes a main vessel shield 60, a door shield system 116, corner shields 196, and auxiliary shield panels 208 (discussed below). The main vessel shield 60 includes a plurality of panels 64 formed of radiation shielding material (Figs. 2, 3 and 6). Each panel is shaped to complement a contour of the spherical containment vessel 24 and in particular, a portion of the containment vessel 24 adjacent where the panel 64 is positioned. In the illustrated embodiment, the shape of the panels 64 positioned adjacent the door frame 40 is modified to fit around the door frame 40.

[0024] As shown in Fig. 2, each panel 64 includes a first end 68, a second end 72 and first and second side edges 76, 80. The panels 64 are arranged about a circumference of the containment vessel 24 such that the first side edge 76 and the second side edge 80 of adjacent panels 64 abut The first end 68 of the panel 64 is coupled to the base 52 or the bottom portion 56 of the containment vessel 24, and the second end 72 of the panel 64 is coupled to a top portion 84 of the containment vessel 24. For example, the panels 64 may be mounted to fasteners 86 attached to the containment vessel 24, coupled to the containment vessel 24 at attachment points (not shown) welded to the outer wall 28, or the like. In one embodiment, there is an air gap between the outer wall 28 of the containment vessel 24 and the panels 64 to provide a tolerance between the two.

[0025] The main vessel shield 60 also includes a plurality of seam plates 88 (Figs. 3-5). Each seam plate 88 is positioned over a seam (not shown) between adjacent panels 64 and is

coupled to the adjacent panels 64. The seam plates 88 are shaped to complement the contour of the adjacent panels 64 and the spherical containment vessel 24. The seam plate 88 overlaps the adjacent panels 64 to prevent line-of-sight radiation exposure, or exposure to other hazardous materials, from the containment vessel 24 at the seam. As shown in Fig. 4, fasteners 96 are attached to each panel 64 and the seam plate 88 includes U-shaped brackets 100 for sliding engagement with the fasteners 96. It should be readily apparent to those of skill in the art that other fastener means may be used to couple the seam plates 88 to the panels 64.

[0026] Fig. 6 is a section view of a panel 64 of the main vessel shield 60 that shows multiple layers and materials forming the panel 64. In the illustrated embodiment, the panel 64 is formed from two layers of stainless steel plating 104, 108 that are formed or molded around a radiation shielding core 112. In some embodiments, the core 112 includes or is formed from lead. However, in other embodiments, the core 112 includes or is formed from other radiation shielding materials, such as tungsten. The seam plate 88 is formed from two layers of stainless steel plating formed or molded around a radiation shielding core as well.

[0027] The radiation shielding core 112 has a thickness sufficient to contain radiation in the interior area 32 of the containment vessel 24 and prevent radiation or hazardous materials dispersal to the atmosphere. In one embodiment, the core 112 has a thickness of about 0.25 to about 0.8 inches, however, it should be readily apparent to one of skill in the art that the thickness of the core 112 is proportional to the level of shielding required.

[0028] In other embodiments, the main vessel shield 60 is manufactured from or includes other materials, including plastics, other synthetic materials, ceramics, fiberglass, iron, and the like, which comprise a radiation shielding material or encase a radiation shielding core. In these embodiments, the main vessel shield 60 is molded (e.g., injection molded) from a plastic material or the main vessel shield 60 is manufactured in any other manner, such as by casting, stamping, machining, bending, pressing, extruding, or other manufacturing operations. In still another embodiment, the radiation shielding core 112 is coated with a protective layer, such as plastic, ceramic, or other synthetic materials. In addition, the main vessel shield may be formed from at least one lead wool blanket, which may be encased, that is positioned adjacent the containment vessel 24.

[0029] In embodiments such as the illustrated embodiment of Figs. 1-5 having stainless steel plating and a core, the steel plating absorbs and contains explosions, minimizing the potential dangers of objects contained in the interior area 32. The steel plating also protects objects contained in the interior 32 area from impacts and environmental damage during storage and transportation of the objects. In these embodiments, the core 112 operates to absorb and contain explosions and to protect the environment external to the containment vessel 24 from hazardous materials within the interior area 32, including radiation. The core 112 also provides radiological insulation to contain or minimize the dispersion of potential harmful radiological or nuclear materials contained in the interior area 32, during transport, storage or detonation of the explosives.

[0030] In embodiments having multiple layers and/or being formed of multiple sheets, the layers and/or sheets are welded together. Alternatively, the layers and/or sheets are secured together by threaded fasteners, rivets, pins, clamps, or other fasteners, by snap fits, inter-engaging elements, adhesive or cohesive bonding material, by brazing, or soldering, and the like. In one embodiment, the main vessel shield 60 is formed from a single continuous sheet rather than multiple panels and seam plates.

[0031] In some embodiments, the main vessel shield 60 includes a seal including radiation shielding material, which is positioned between the shield 60 and the outer wall 28 of the containment vessel 24 to prevent radiological materials or other hazardous materials from leaking out of the interior area 32 between the shield 60 and the outer wall 28. In these embodiments, the seal can include interlocking or overlapping protrusions, panels, or tabs. In other embodiments, the seal can include one or more elastic and/or insulating elements positioned between the shield 60 and the outer wall 28 of the containment vessel 24.

[0032] As can be seen in Figs. 2-4, the panels 64 are arranged such that the top portion 84 and the bottom portion 56 of the containment vessel 24 remain exposed, which does reduce the weight of the radiation shielding system 26. It should be readily apparent to one of skill in the art that in further embodiments no portions of the containment vessel 24 are exposed, either the top or bottom portion 84, 56 is exposed, or other portions of the containment vessel 24 may be exposed. For example, in one embodiment, radiation shielding panels are positioned at the top and bottom exposed portions 84, 56 of the containment vessel 24 to completely enclose the containment vessel 24.

[0033] As shown in Figs. 1, 4 and 5, the radiation shielding system 26 includes a door shield system for containing and minimizing radiation emissions from the interior area 32 of the containment vessel 24 at areas adjacent the opening 36, the door frame 40 and the door 44. The door shield system includes a pair of radiation shielding frame sleeves 120, 124 configured and adapted for covering external surfaces of the door frame 40. In Fig. 4, frame sleeve 120 is shown attached to the door frame 40 and frame sleeve 124 is shown detached from the door frame 40. The frame sleeves 120, 124 are attached to the door frame 40 with threaded fasteners 128, however, it should be readily apparent that other fastener means may be used, such as rivets, pins, clamps, or other fasteners, by snap fits, inter-engaging elements, adhesive or cohesive bonding material, by brazing, or soldering, and the like.

[0034] Each frame sleeve 120, 124 is formed or molded to complement the contour of the door frame 40. The frame sleeves 120, 124 cover, or encase, external surfaces of the door frame 40 to contain or minimize radiation within the interior area 32 from traveling to the external environment through the door frame 40 or areas between the door frame 40 and the adjacent panels 64. As shown in Figs. 4 and 5, the frame sleeves 120, 124 overlap a portion of the adjacent panels 64 to prevent line-of-sight radiation exposure from between the door frame 40 and the panel 64. In a further embodiment, the frame sleeves 120, 124 include fewer of more components, for example, a single sleeve is configured for covering the door frame 40.

[0035] In the closed position, the door 44 is received by the opening to prevent access to the interior area 32. As shown in Fig. 5, an arm 132 pivotally connected to the support frame 42 supports the door 44 and a pair of brackets 136 connect the door 44 to the arm 132. The door shield system includes a door shield 140 for covering an external surface of the door 44, and preventing or minimizing radiation emissions from the interior area 32 of the containment vessel 24 through the door 44 and a seam 144 between the door 44 and the door frame 40. The door shield 140 has a size sufficient to cover the door 44 and the door frame 40 of the containment vessel 24.

[0036] The door shield 140 includes a pair of substantially semi-circular shield portions 148, 152 that are coupled to the door 44 of the containment vessel 24. Each shield portion 148, 152 includes a pair of notches 156 such that when the door shield 140 is attached to the door 44, the notches 156 fit around the brackets 136. Further, each shield portion 148, 152 includes a radially extending flange 148A, 152A positioned to cover a seam between the two

frame sleeves 120, 124 coupled to the door frame 40. Each shield portion 148, 152 includes an inner band 148B, 152B spaced radially inward from an outer perimeter 148C, 152C of the respective shield portion 148, 152. The inner bands 148B, 152B and the outer perimeters 148C, 152C fit between an inner edge of the door frame 40 and an outer edge of the door frame to prevent line-of-sight radiation through the door frame 40. In the illustrated embodiment, the lower shield portion 148 includes a flange 160 for covering a seam between the two door shield portions 148, 152. In a further embodiment, the door 44 is formed from a radiation shielding material, such as tungsten, lead or the like, therefore, eliminating the need for a door shield, although supplemental shields may be used to provide shielding at seams of the containment vessel 24.

[0037] The door shield system also includes an upper shield 172, a lower shield 176 and a door mount shield 180. As shown in Fig. 4, the upper shield 172 is positioned over an upper exposed area 184 of the containment vessel 24 behind a top portion of the door frame 40 and between the two panels 64 positioned adjacent the door frame 40. The upper shield 172 prevents or minimizes radiation dispersal to the external environment through the upper exposed area 184. The upper shield 172 attaches to the outer wall 28 of the containment vessel 24. It should be readily apparent to those of skill in the art that other upper shield configurations may be used to cover the exposed area 184 behind the door frame 40 and between the two panels 64 positioned adjacent the door frame 40.

[0038] As shown in Fig. 4, the lower shield 176 includes a first shield portion 188 and a second shield portion 190 positioned over a lower exposed area (not shown) at the bottom portion 56 of the containment vessel 24 and between the panels 64 positioned adjacent the door frame 40. The first shield portion 188 of the lower shield 176 extends between and is coupled to two front corner shields 196 (discussed below). The first shield portion 188 covers a portion of the exposed area behind a bottom portion of the door frame 40 and between the two front corner shields 196. The second shield portion 192 is coupled to the first shield portion 188 and extends downward from the first shield portion 188 (Fig. 4) and over a portion of a front face 200 of the base 52. The second shield portion 192 covers a portion of the exposed area behind the bottom portion of the door frame 40 and between the first shield portion 188 and the base 52. It should be readily apparent to those of skill in the art that other lower shield configurations may be used to cover the exposed area behind the door frame 40 and between the two panels 64 positioned adjacent the door frame 40. For

example, in one embodiment a radiation shielding plate is mounted to the front face 200 of the base 52.

[0039] As illustrated by Figs. 1 and 5, the door mount shield 180 encloses the door brackets 136 and a portion of the arm 132 to prevent or minimize radiation emissions from the interior area 32 through seams between the door shield portions 148, 152 and the brackets 136. It should be readily apparent to those of skill in the art that the door mount shield 180 may include any number of shield portions.

[0040] In a preferred embodiment, the shield portions of the door shield system are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the shield portions are formed from any number of the materials and layers discussed above with respect to the main vessel shield 60.

[0041] As illustrated in Figs. 1, 4 and 5, the radiation shielding system 26 includes four corner shields 196 for preventing or minimizing radiation emissions from the containment vessel 24 through openings where the containment vessel 24 is attached to the base 52. As seen in Figs. 2 and 3, the containment vessel 24 is attached to the base 52 by mounting brackets 54. The panels 64 of the main vessel shield 60 are configured to fit around the mounting brackets 54, which leaves openings to the outer wall 28 of the containment vessel 24. Each corner shield 196 is positioned to cover one mounting bracket 54 and overlap the adjacent panels 64. Although the mounting brackets 54 and corner shields 196 are positioned in the four corners of the base 52, in further embodiments, fewer or more mounting brackets 54 and corner shields 196 may be used and positioned in alternate positions around the circumference of the containment vessel 24. In a preferred embodiment, the corner shields 196 are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the corner shields 196 are formed from any number of the materials and layers discussed above with respect to the main vessel shield 60.

[0042] As shown in Fig. 1, the radiation shielding system 26 includes auxiliary shield panels 208 mounted to the support frame 48 of the containment vessel 24. The auxiliary shield panels 208 prevent or minimize radiation emissions from radioactive materials within the interior area 32 of the containment vessel 24 through a seam between the panels 64 of the main vessel shield 60 and the frame sleeves 120, 124 of the door shield system 116. Each auxiliary shield panel 208 is mounted to the support frame 48 and extends between an upper

frame portion 212 to the base 52 adjacent an exposed area to be covered. In a preferred embodiment, the auxiliary shield panels 208 are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the auxiliary shield panels 208 are formed from any number of the materials and layers discussed above with respect to the main vessel shield 60.

[0043] Figs. 7-9 illustrate another embodiment of a shielded containment system 220 embodying the invention, in which like features with the embodiment shown in Figs.1–5 are identified by the same numerals. The shielded containment system 220 includes the device containment vessel 24 and a radiation shielding system. The containment vessel 24 is supported by and mounted to the support frame 48 that includes the base 52. The containment vessel 24 includes the outer wall 28, which at least partially encloses an interior area (not shown) for receiving explosive materials. In the illustrated embodiment, the containment vessel 24 has a substantially spherical shape. The containment vessel 24 includes the opening 36 through the outer wall 28 for accessing the interior area and the door frame 40, which substantially surrounds the opening 36. The door frame 40 supports the door 44 for movement relative to the door frame 40 between an open position in which the door 44 is moved away from or out of the opening 36, and a closed position (shown in Fig. 7), preventing access to the interior area through the opening 36.

[0044] The radiation shielding system includes a main vessel shield 224, a door frame shield 228 and a door shield 232. The main vessel shield 224 includes a plurality of panels 236 and a pair of frame rings 240, 242 mounted to the containment vessel 24 for coupling the panels 236 thereto. Figs. 8 and 9 illustrate construction of the main vessel shield 224. The panels 236 are shaped to complement a contour of the spherical containment vessel 24. Each panel 236 includes a first end 244, a second end 248 and first and second side edges 252, 256. The first end 244 of the panel 236 is coupled to the upper frame ring 240 and the second end 248 of the panel 236 is coupled to the lower frame ring 242. The panels 236 are arranged about a circumference of the containment vessel 24 such that the first edge 252 and the second edge 256 of adjacent panels 236 abut.

[0045] Each panel 236 includes a seam plate 260 extending laterally from a top surface 264 of the second edge 256 of the panel 236. The seam plate 260 overlaps the first edge 252 of he adjacent panel 236 and is positioned over a seam 268 between adjacent panels 236. The seam plate 260 prevents line-of-sight radiation dispersal, or dispersal of other hazardous

materials, from the containment vessel 24 at the seam 268. In the illustrated embodiment, the seam plate 260 is integrated with the second edge 256 of the panel 236, however, those skilled in the art will recognize that in further embodiments, the seam plate 260 may be a separate piece.

[0046] The radiation shielding system includes the door frame shield 228 that absorbs and contains radiation emissions from the interior area of the containment vessel 24 at areas adjacent the opening 36 and the door frame 40 that are not protected by the main vessel shield 224. The door frame shield 228 includes a substantially rectangular plate 272 shaped to complement a contour of the containment vessel 24, and having an opening 276 configured to fit around and abut the door frame 40.

[0047] In the illustrated embodiment, the door shield 232 is coupled to the arm 132 of the containment vessel 24 and covers an exterior surface of the door 44 to prevent or minimize radiation emissions from the interior area of the containment vessel 24 at the door and the door frame 40. The door 44 shield 232 has a size sufficient to cover the door 44 and the door frame 40 of the containment vessel 24. In a further embodiment, the door shield 232 is attached directly to the door 44 or the door itself is formed of a radiation shielding material.

[0048] As seen in Figs. 7 and 9, the radiation shield system keeps exposed the top portion 84 and a bottom portion (not shown) of the containment vessel 24. It should be readily apparent to one of skill in the art that in further embodiments no portions of the containment vessel 24 will be exposed or other portions may be exposed. For example, in one embodiment, radiation shielding panels are positioned at the exposed portions of the containment vessel 24.

[0049] In a preferred embodiment, each shield component of the radiation shielding system is formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the shield components may be formed from any number of materials and layers discussed above with respect to Figs. 1-5.

[0050] In a preferred embodiment, the shielded containment systems discussed above are factory fabricated and assembled. However, on one embodiment, the radiation shield system is field fabricated and attached to the containment vessel.

[0051] Figs. 10 and 11 illustrate an interior radiation shielding system 320 for a containment vessel 324 having a similar construction to the containment vessel 24 shown in Figs. 1-5. The radiation shielding system 320 is positioned adjacent an interior surface 328 of an outer wall 332 of the containment vessel 324. The radiation shielding system 320 includes a plurality of radiation shielding panels 336 shaped to complement an internal contour of the spherical containment vessel 324. Each panel 336 includes a first end 340, a second end 344, and first and second side edges 348, 352. The first end 340 of each panel 336 is coupled to the containment vessel 324 adjacent a door opening 356, and the second end 344 is coupled to a rear portion of the containment vessel 324. A radiation shielding end cap 364 is coupled to the containment vessel 324 at the rear portion 360 to cover an open area at the second ends 344 of the panels 336. In the illustrated embodiment, the panels 336 are configured and arranged in a horizontal direction, however, in a further embodiment the panels 336 may be configured and arranged in another direction, such as vertical.

[0052] The panels 336 are arranged about the interior circumference of the containment vessel 324 such that the first edge 348 and the second edge 352 of adjacent panels 336 abut. A seam 368 between adjacent panels 336 are tack welded together, however, the panels 336 may also be attached at the seams 368 by other mechanical fastener means known in the art In a further embodiment, seam plates (not shown) are positioned over each seam 368 between adjacent panels 336 to overlap adjacent panels 336 and prevent or minimize line-of-sight radiation dispersal, or dispersal of other hazardous materials, from the containment vessel at the seam 368. In this embodiment, at least a door shield (not shown) would be required to contain radiation in the interior area at the opening 356 of the containment vessel 324.

[0053] In one embodiment, the interior radiation shielding system 320 is fabricated and assembled prior to assembly of the containment vessel 324. For example, the containment vessel 324 is formed from two halves of pressed steel welded together to form a sphere. To assemble the radiation shielding system 320, the panels 336 and seam plates are positioned and arranged in each half of the vessel prior to vessel assembly. After the radiation shielding system 320 is assembled, the two halves of the containment vessel 324 are coupled together. The radiation shielding system 320 is incompressible, and after assembly of the containment vessel 324, an explosive is detonated within the interior area to tightly press the panels 336 to the outer wall 332 of the containment vessel 324.

[0054] In a preferred embodiment, the panels 336 and other components of the interior radiation shield system 320 are formed by welding together two layers of stainless steel plating with a radiation shielding core therebetween. Alternatively, the panels 336 may be formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the panels 336 and other components of the radiation shielding system 320 may be formed from any number of materials and layers discussed above with respect to Figs. 1-5.

[0055] Figs. 12 and 13 illustrate the shielded containment system 220 of Fig. 7 including a supplemental radiation shield. The supplemental radiation shield is attached to the containment vessel 24 or the support frame 48 as needed to provide additional protection against radiation dispersed from the containment vessel 24. For example, when hazardous materials having greater radioactive properties are stored in the containment vessel 24, the supplemental radiation shield is used in addition to the radiation shielding system discussed above. The supplemental radiation shield is either factory mounted to the containment vessel 24, or added on in the field as needed.

[0056] Fig. 12 illustrates one embodiment of a supplemental radiation shield 420 including radiation shielding blankets mounted to the upper frame ring 240 of the radiation shielding system and covering the panels 236. In the illustrated embodiment, the supplemental radiation shield comprises multiple blankets, however, in further embodiments the supplemental radiation shield comprises a single blanket arranged around the containment vessel. In a preferred embodiment, the blankets 420 are formed from lead wool rope and are encased in a nylon reinforced PVC covering. It should be readily apparent to those of skill in the art that other radiation shielding materials may be used to form the blankets 420, other materials for the blanket covering may be used, or the covering may be eliminated.

[0057] Hooks 424 are hung from the upper frame ring 240 for supporting the blankets 420, although in a further embodiment other fasteners may be used to attach the blankets 420 to the radiation shielding system. In another embodiment, the supplemental radiation shield 420 includes a plurality of radiation shielding panels coupled to the frame rings 240, 242 and covering the panels 236 of the radiation shielding system.

[0058] Fig. 13 illustrates another embodiment of the supplemental radiation shield 520 including a plurality of radiation shielding panels 524 mounted to the support frame 48 of the

containment vessel 24 and substantially surrounding the containment vessel 24. Each panel 524 includes a first end 528, a second end 532, and first and second side edges 536, 540. The first end 528 of the panel 524 is coupled to the upper portion 212 of the support frame 48 and the second end 532 of the panel 524 extends to the base 52. The panels 524 are arranged about a periphery of the support frame 48 such that the first edge 536 and the second edge 540 of adjacent panels 524 abut.

[0059] The second edge 540 of each panel 524 includes a seam plate 544 extending laterally from a top surface of the second edge 540 of the panel 524. When the panels 524 are attached to the support frame 48 and positioned adjacent each other, the seam plate 544 is positioned over a seam 552 between adjacent panels 524 and overlaps the first edge 536 of the adjacent panel 524. The seam plate 544 prevents line-of-sight radiation dispersal, or dispersal of other hazardous materials, from the containment vessel at the seam 552. In the illustrated embodiment, the seam plate 544 is integrated with the second edge of the panel, however, those of skill the art will recognize that in further embodiments, the seam plate 544 may be a separate piece.

[0060] In a preferred embodiment, the panels 524 of the supplemental radiation shield system 520 are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the panels 524 may be formed from any number of materials and layers discussed above with respect to Figs. 1-5. For example, the panels 524 may each be formed from a lead wool blanket, as shown in Fig. 12, or a single lead wool blanket may be mounted to the support frame 48.

[0061] In another embodiment of the radiation shielding system, the shielded containment vessel includes either the supplemental radiation shields shown in Figs. 12 and 13 as a primary vessel shield, but does not include the main vessel shield, i.e. the plurality of panels, attached to the containment vessel. In this embodiment, the supplemental radiation shield has a thickness sufficient to prevent or minimize radiation emissions from the interior area of the containment vessel. In yet another embodiment of the shielded containment system, a thermometer or radiation sensor is used to measure radiation levels from the containment vessel, which helps determine whether a supplemental radiation shield is necessary.

[0062] In operation, when a hazardous object, such as an explosive device, is located, a shielded containment system is moved to the location of the hazardous object. The door is then moved toward the open position and the hazardous object is inserted into the interior area. In some embodiments, robots, operators, conveyor belts, forklifts, and other product moving devices are also or alternatively used to move hazardous objects into the interior area. Once the hazardous object is positioned in the interior area, an operator moves the door toward the closed position to isolate the hazardous object. In an embodiment having latches, the latch is also moved toward a locked position to secure the door in the closed position.

[0063] Once a hazardous object is loaded into the interior area and the door is in the closed position, the containment system is moved to a remote location for safe disposal, storage or inspection. If a hazardous object explodes, leaks, releases harmful agents or materials, or releases radiation while sealed in the interior area, the radiation shielding system and optional supplemental radiation shield contain the harmful agents or materials in the interior area and prevent these harmful agents or materials from escaping to the atmosphere and causing harm to the operator or other people or animals in the area. The outer wall of the containment vessel, the door, and/or the radiation shielding system all help contain the explosion blast.

[0064] It should be readily apparent to those of skill in the art that in further embodiments of the radiation shielding panels described above, any number of panels may be used to form the radiation shield (e.g., as few as one or two panels to more than 15), the panels may have other configurations or shapes than those shown in the figures, and the panels may be oriented in other directions (e.g., vertically).

[0065] Various features and advantages of the invention are set forth in the following claims.

CLAIMS

What is claimed is:

1. A radiation shield comprising:

a plurality of panels formed of a radiation shielding material, the panels shaped to complement a contour of a vessel and arranged proximate a portion of the vessel; and

a plurality of seam plates, each seam plate positioned along a seam between adjacent panels and overlapping adjacent panels.

2. The radiation shield of claim 1, wherein the panels are arranged to surround an exterior surface of the vessel.

3. The radiation shield of claim 1, wherein the panels are positioned adjacent an interior surface of the vessel.

4. The radiation shield of claim 3, and further comprising an end cap formed of radiation shielding material, the end cap positioned at one end of the plurality of panels to cap an opening formed at the end of the plurality of panels.

5. The radiation shield of claim 1, and further comprising a frame wherein the vessel is at least partially disposed within the frame and the panels are coupled to the frame.

6. The radiation shield of claim 5, wherein the frame is mounted to the vessel.

7. The radiation shield of claim 5, wherein the vessel is supported by a base and the frame is mounted to the base.

8. The radiation shield of claim 1, and further comprising a supplemental shield formed of a radiation shielding material and selectively coupled to the frame, the supplemental shield being positioned relative to the plurality of panels wherein the plurality of panels are positioned between the supplemental shield and the vessel.

9. The radiation shield of claim 8 wherein the supplemental shield includes a lead wool blanket.

10. The radiation shield of claim 8 wherein the supplemental shield includes a plurality of panels.

11. The radiation shield of claim 1, wherein each plate member has a first edge and a second edge and the seam plate is integrally formed with the first edge of the respective panel to overlap the adjacent panel.

12. The radiation shield of claim 1, and further comprising a door shield formed of a radiation shielding material and coupled to an exterior surface of a door of the vessel.

13. The radiation shield of claim 1 wherein the panel includes a lead shield encased in stainless steel.

14. A device containment apparatus comprising:

a vessel for storing a radioactive device, the vessel including an outer wall defining an interior area;

a shield formed of radiation shielding material, the shield positioned adjacent the vessel for minimizing dispersal of radioactive material from the interior area of the vessel.

15. The device containment apparatus of claim 14, wherein the shield is positioned and arranged to surround an exterior surface of the outer wall.

16. The device containment apparatus of claim 15, wherein the vessel is supported by a base and the shield is mounted to the base.

17. The device containment apparatus of claim 14, wherein the shield is positioned adjacent an interior surface of the outer wall.

18. The device containment apparatus of claim 14, wherein the shield includes at least one lead wool blanket.

19. The device containment apparatus of claim 14, wherein the shield includes a plurality of panels coupled together and shaped to complement a contour of the vessel.

20. The device containment apparatus of claim 19, and further comprising a plurality of seam plates formed of radiation shielding material, each seam plate coupled to adjacent panels to overlap a seam between adjacent panels.

21. The device containment apparatus of claim 19, and further comprising an end cap formed of radiation shielding material, the end positioned at one end of the plurality of panels to cap an opening formed at the end of the plurality of panels..

22. The device containment apparatus of claim 19, wherein the shield includes a lead core encased in stainless steel.

23. The device containment apparatus of claim 14, wherein the shield is attached to the vessel.

24. The device containment apparatus of claim 14, and further comprising a frame wherein the vessel is at least partially disposed within the frame and the panels are coupled to the frame.

25. The device containment apparatus of claim 14, and further comprising a supplemental shield formed of a radiation shielding material and selectively positioned relative to the shield wherein the shield is positioned between the supplemental shield and the vessel.

26. A device containment apparatus for storing an explosive device and minimizing dispersal of radioactive material, the device containment apparatus comprising:

a vessel including an outer wall defining an interior area;

an opening through the outer wall for accessing the interior area;

a door providing access to the interior area of the vessel; and

a radiation shield formed of a radiation shielding material and positioned adjacent to a portion of the vessel.

27. The device containment apparatus of claim 26, wherein the radiation shield is positioned and arranged to surround an exterior surface of the vessel.

28. The device containment apparatus of claim 26, wherein the radiation shield is positioned within the interior area and adjacent an interior surface of the vessel.

29. The device containment apparatus of claim 26 wherein the radiation shield comprises a plurality of panels coupled together and shaped to complement a contour of the vessel.

30. The device containment apparatus of claim 29, wherein each panel overlaps with an adjacent panel to prevent line of sight radiation.

31. The device containment apparatus of claim 29, and further comprising a seam plate positioned along a seam between adjacent panels and overlapping adjacent panels.

32. The device containment apparatus of claim 29, and further comprising an end cap formed of radiation shielding material, the end cap positioned at one end of the plurality of panels to cap an opening formed at the end of the plurality of panels.

33. The device containment apparatus of claim 26, and further comprising a frame wherein the vessel is at least partially disposed within the frame and the radiation shield is coupled to the frame.

34. The device containment apparatus of claim 33, wherein the frame is mounted to the vessel.

35. The device containment apparatus of claim 26, wherein the vessel is supported by a base and the radiation shield is mounted to the base.

36. The device containment apparatus of claim 26 wherein the radiation shield includes a lead core substantially covered by a casing.

37. The device containment apparatus of claim 26, and further comprising a door shield formed of radiation shielding material, the door shield coupled to an exterior surface of the door.

38. The device containment apparatus of claim 26, and further comprising a supplemental radiation shield selectively positioned relative to the radiation shield, wherein the radiation shield is positioned between the supplemental radiation shield and the vessel.

39. A method for using a device containment vessel to reduce exposure to radioactive material, the method comprising:

providing a device containment vessel including an outer wall defining an interior area, an opening through the outer wall for accessing the interior area, and a door providing access to the interior area of the vessel;

positioning a shield adjacent the outer wall of the vessel, the shield being formed of a radiation shielding material; and

placing an explosive device containing radioactive material in the interior area of the device containment vessel wherein the shield minimizes dispersal of radiation from the explosive device.

40. The method of claim 39, and further comprising detonating the explosive device within the device containment vessel wherein the shield minimizes dispersal of radiation from the explosive device.

41. The method of claim 39 wherein positioning the shield comprises positioning the shield adjacent an exterior surface of the outer wall wherein the shield surrounds a portion of the vessel.

42. The method of claim 39 wherein positioning the shield comprises positioning the shield within the interior area and adjacent an interior surface of the outer wall.

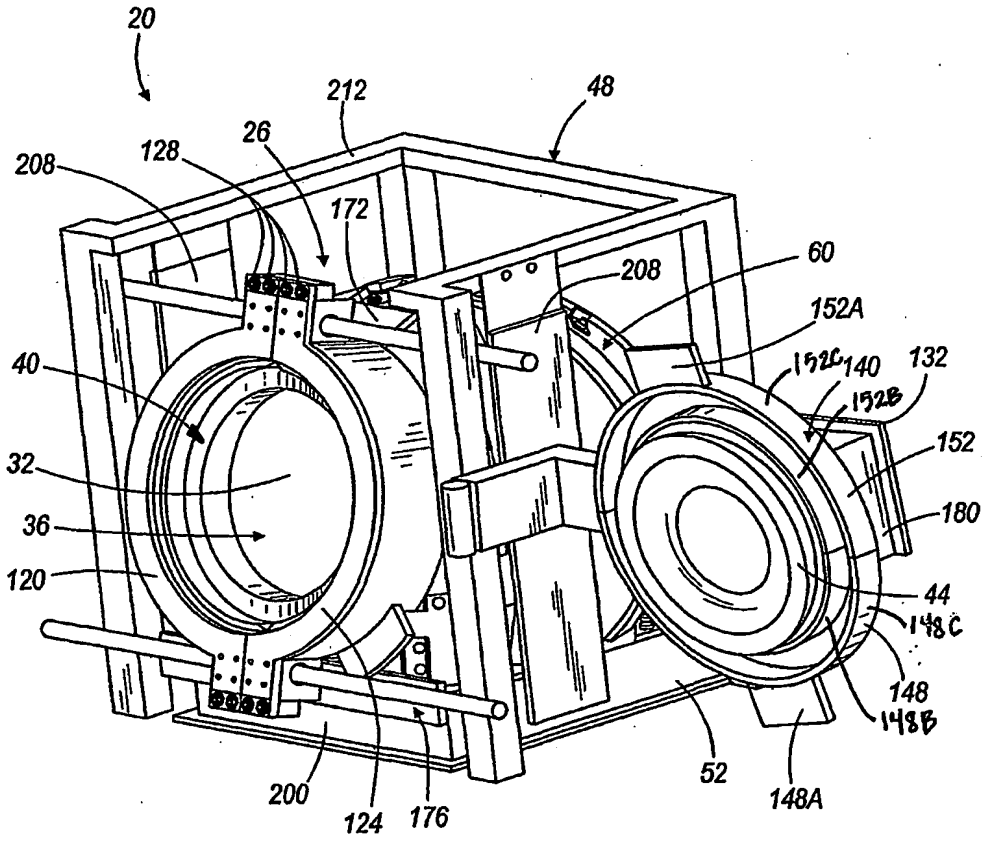
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FIG. 1

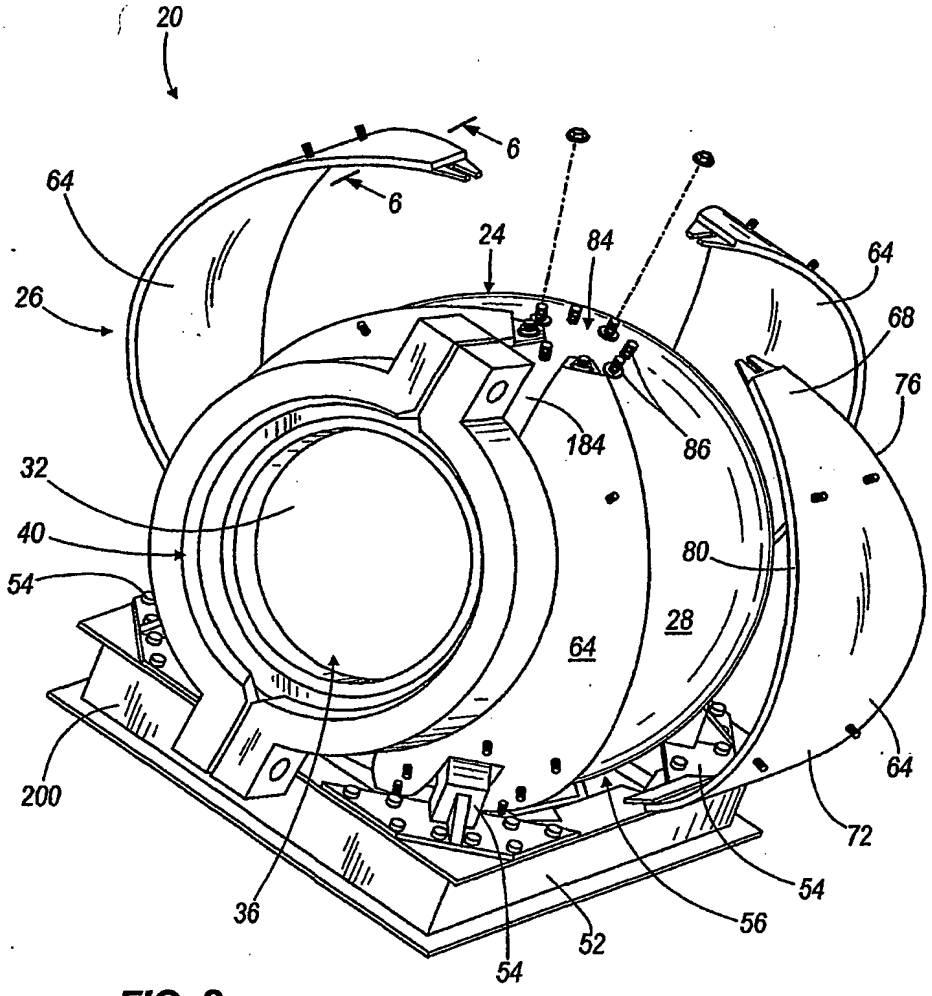
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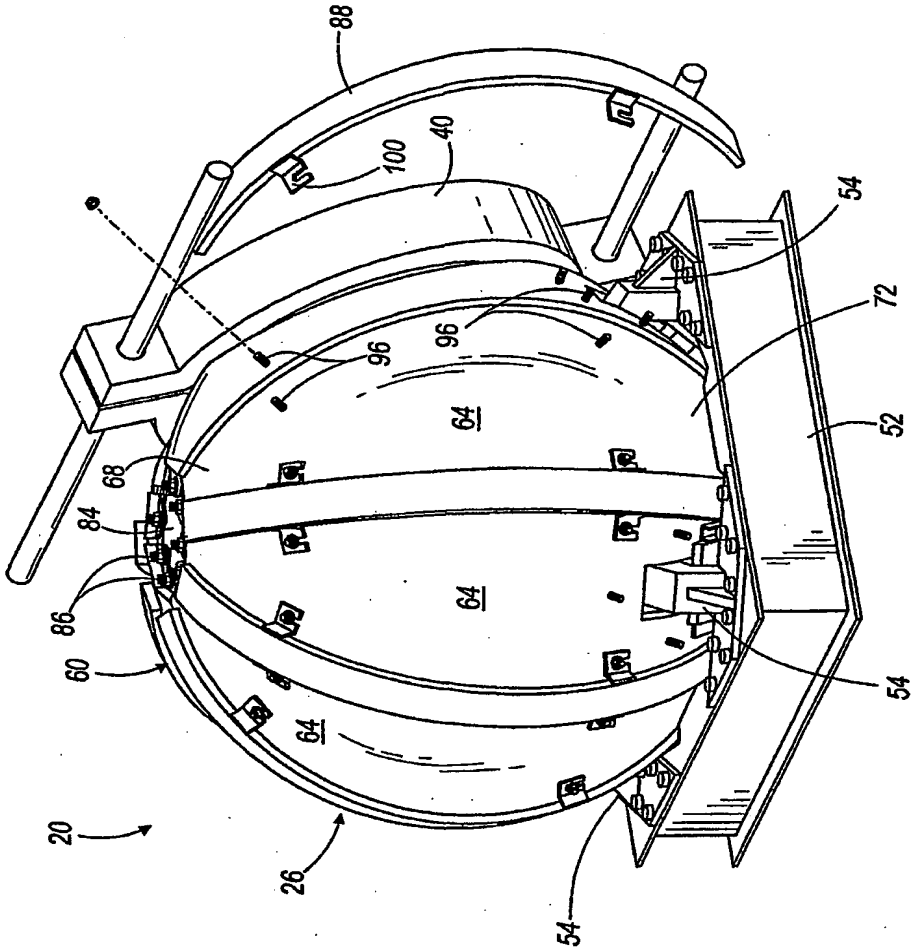
FIG. 2



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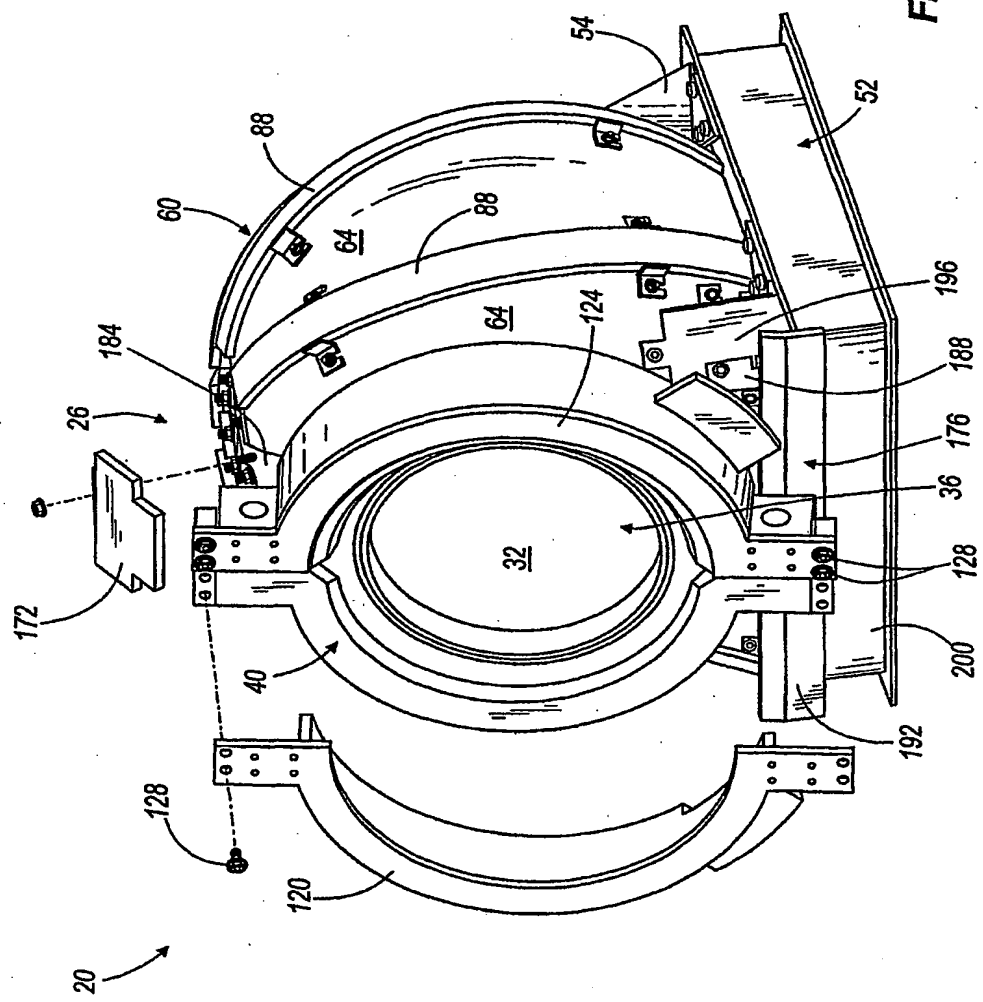
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FIG. 4

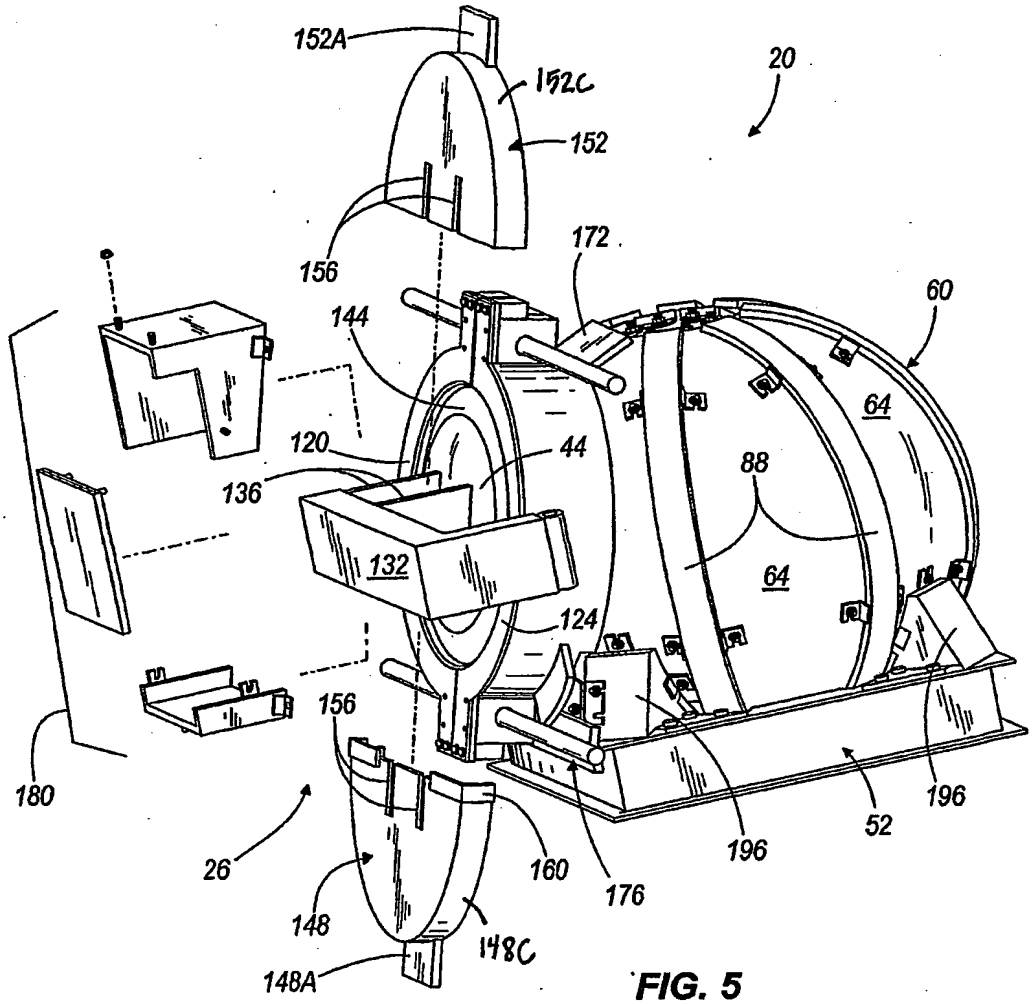
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FIG. 5

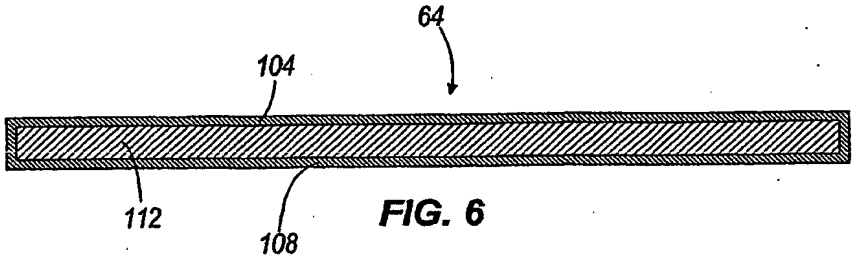

FIG. 6

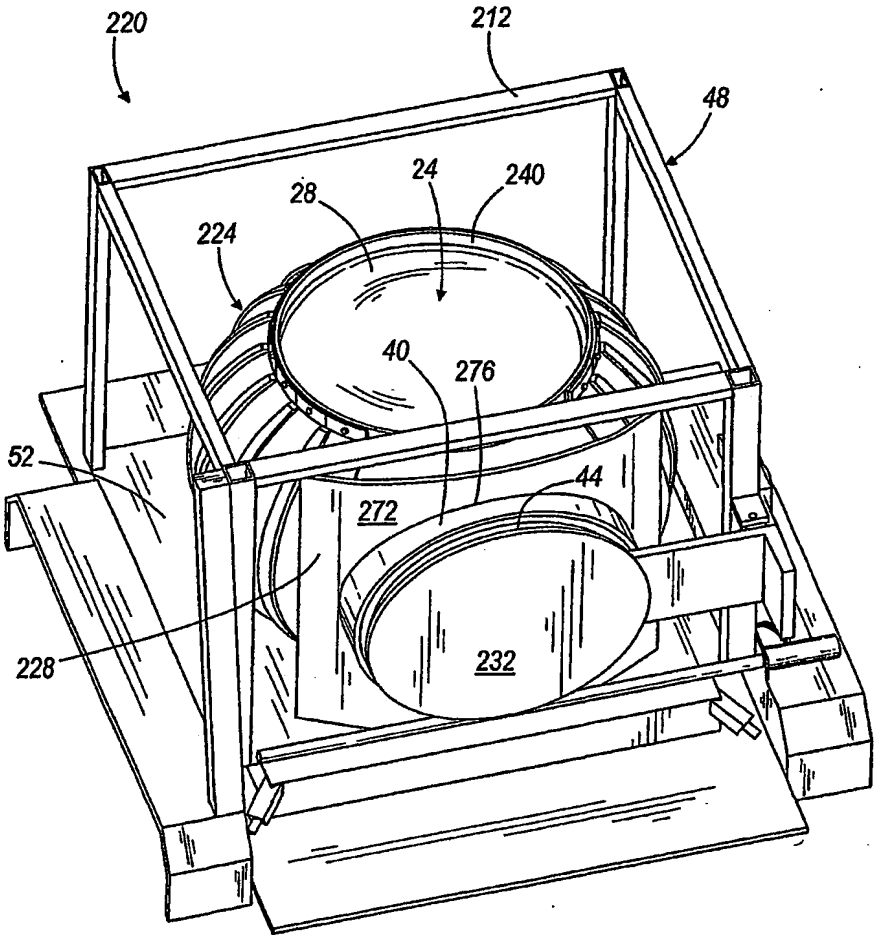

FIG. 7

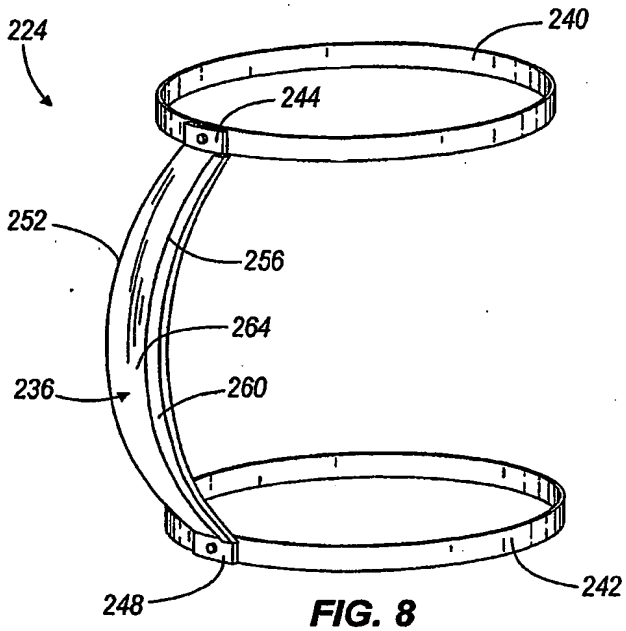
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FIG. 8

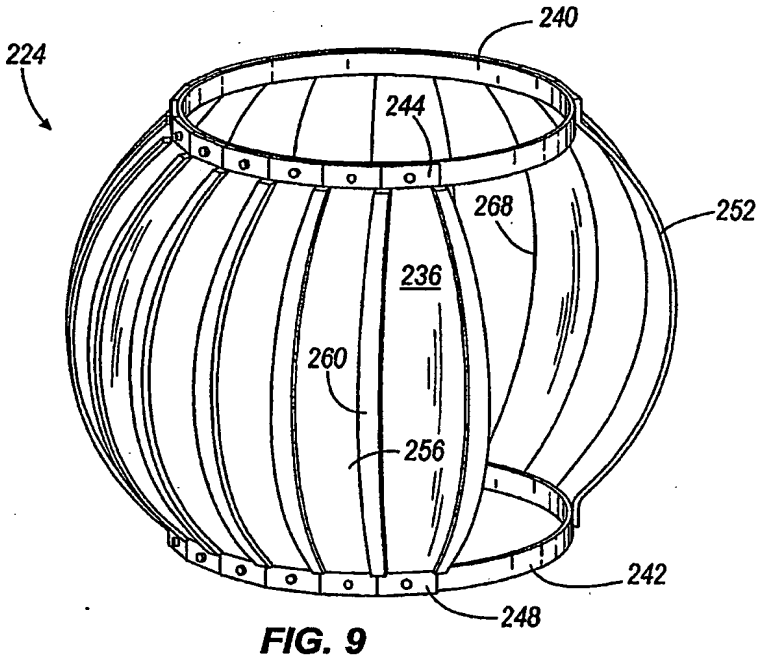
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FIG. 9

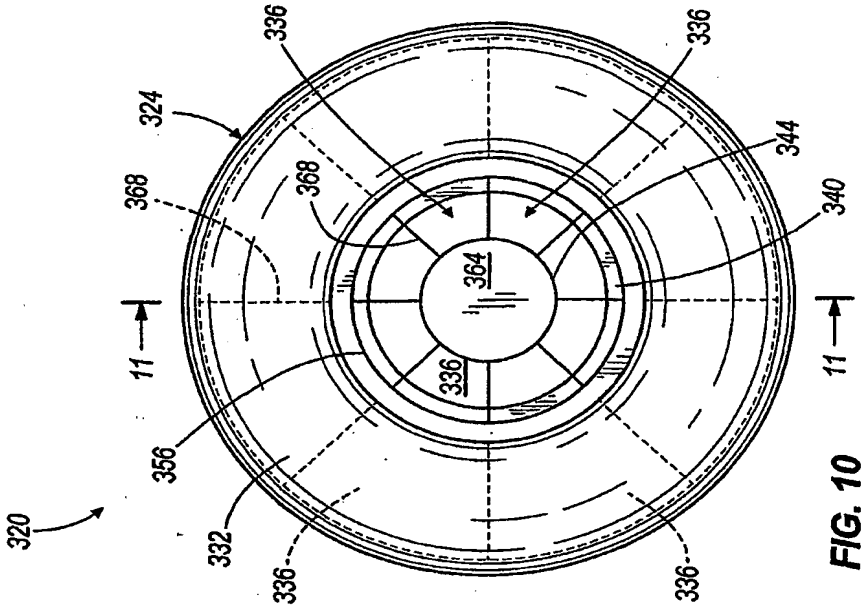
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FIG. 10

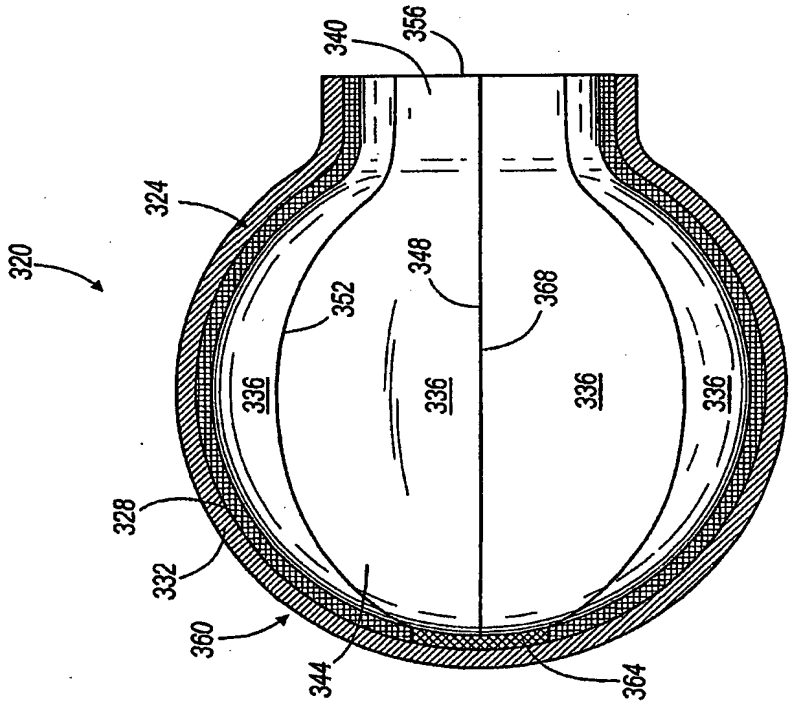
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FIG. 11

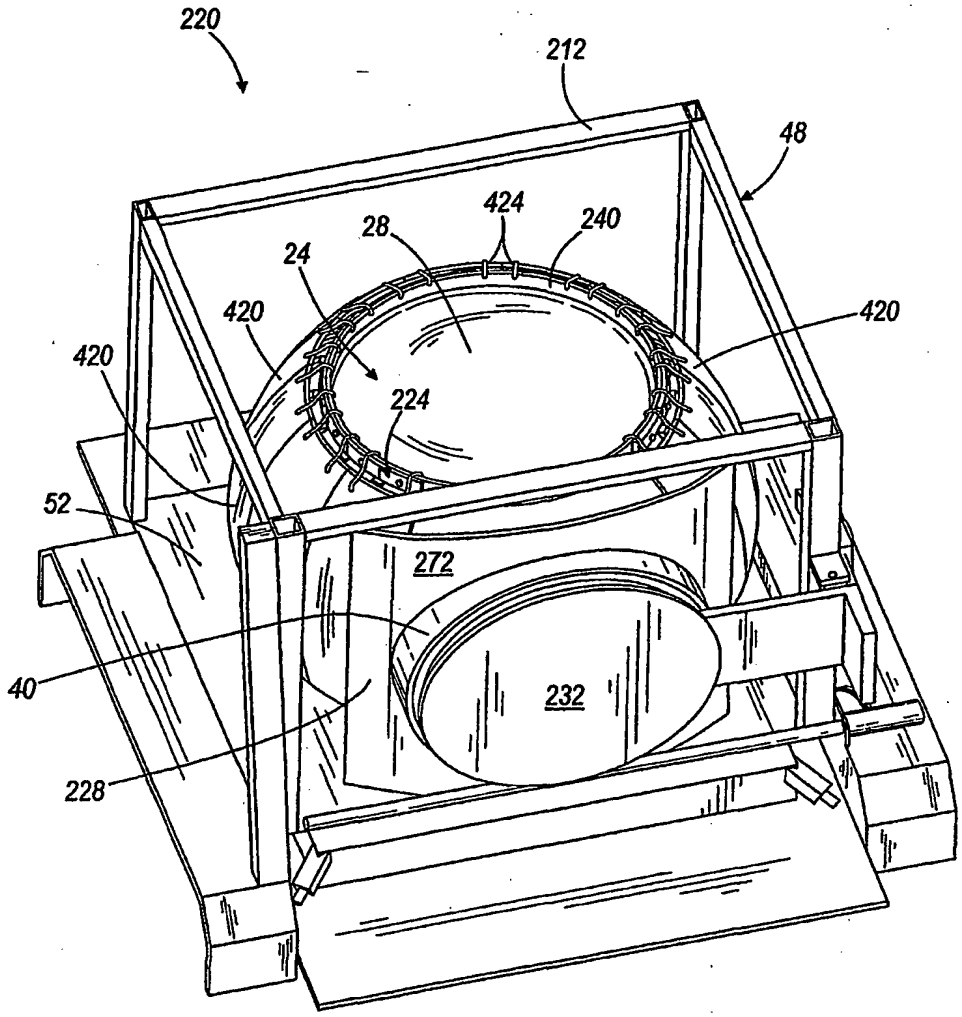

FIG. 12

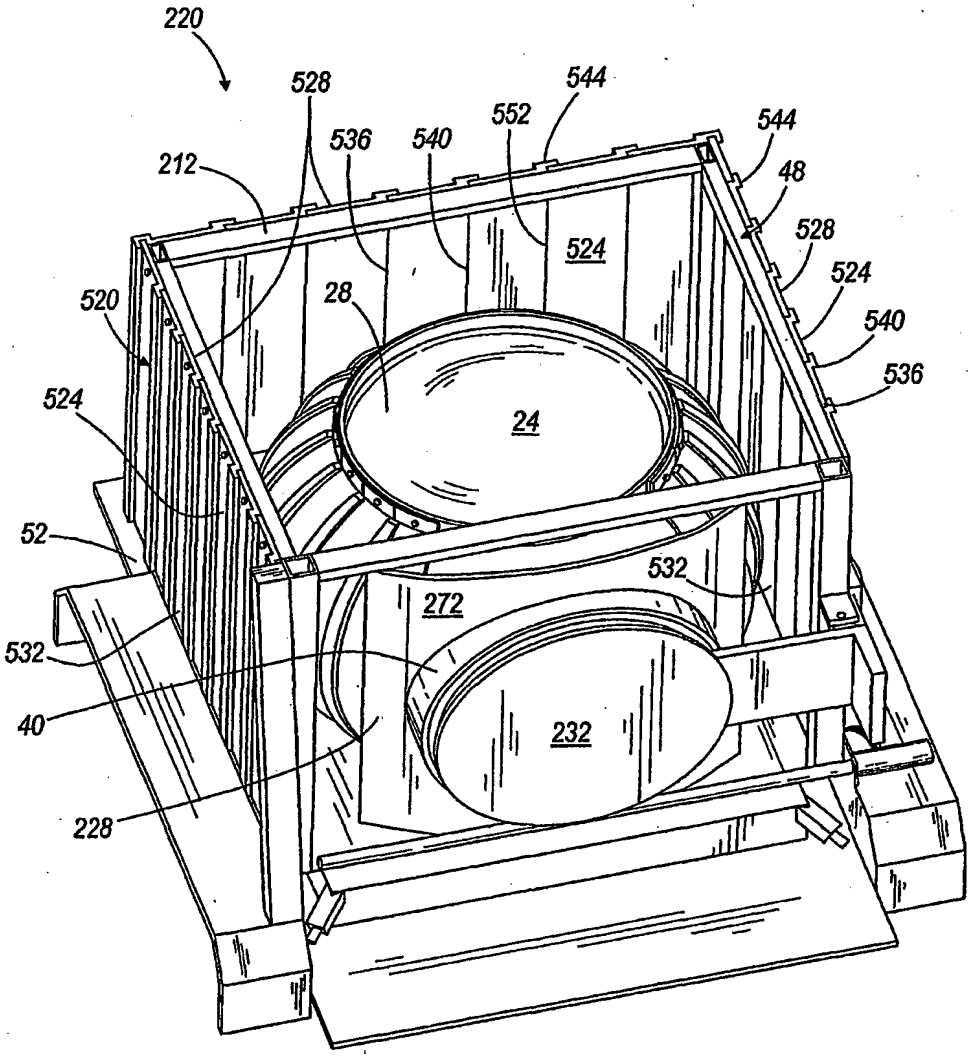
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FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/31248

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F42B 39/14 (2007.01)
USPC - 250/506.1, 515.1; 86/50
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) F42B 39/14 (2007.01)
USPC - 250/506.1, 515.1, 505.1; 86/50; 73/35.17; 220/560.01; 588/16; 102/303

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
USPTO WEST System (US, USPG-PUB, EPO, DERWENT), MicroPatent, IP.com, DialogPro

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,820,435 A (ROGERS et al) 28 June 1974 (28.06.1974) entire document	1-42
Y	US 5,883,394 A (MUSSMAN) 16 March 1999 (16.03.1999) entire document	1-42
A	US 3,820,479 A (FYLLING) 28 June 1974 (28.06.1974) entire document	1-42
A	WO 2005/015119 A1 (BOSIK et al) 17 February 2005 (17.02.2005) entire document	1-42
A	US 2003/0209133 A1 (GREENFIELD et al) 13 November 2003 (13.11.2003) entire document	1-42
A	US 4,187,758 A (PETTY) 12 February 1980 (12.02.1980) entire document	1-42
A	US 4,027,601 A (HICKERSON) 07 June 1977 (07.06.1977) entire document	1-42

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 January 2007	22 FEB 2007
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2005)

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OUR REFERENCE: DE/HS/P05546EP

PAGES *(including this one)*: 2

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TO: EPO

DATE: 09 March 2007

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www.marks-clerk.com

European Patent Office
The Hague
P.O. Box 5818
Patentlaan 2
2280 HV Rijswijk
Netherlands

Your Ref:

Our Ref: DE/HS/P05546EP

Date: 9th March 2007

VIA FACSIMILE TRANSMISSION: 00 49 89 2399 4465

Dear Sirs,

Re: **European Patent Application No. 05858097.8**
In the name of VULCAN LEAD, INC

It has come to our attention that an inventor was inadvertently omitted from the application papers when filing the International patent application.

It is therefore requested that the following individual is added to the list of inventors on your records.

Scott H. Yanke
S64 W39046 County Highway Cl
Dousman
Wisconsin 53118
United States of America

The applicant derives its rights to the invention by virtue of an assignment from Mr Yanke dated 23rd February 2007.

We look forward to receiving your confirmation that this change has been effected.

Yours faithfully,

D.A. EVERY
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P.B.5818 - Patentlaan 2
2280 HV Rijswijk (ZH)
(070) 3 40 20 40
FAX (070) 3 40 30 16

Europäisches Patentamt	European Patent Office	Office européen des brevets
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Every, David Aidan
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Sussex House,
83-85 Mosley Street
Manchester M2 3LG
GRANDE BRETAGNE

EPO Customer Services
Tel.: +31 (0)70 340 45 00

Date
01.12.06

Reference	Application No./Patent No.
	05858097.8 - PCT/US2005031248
Applicant/Proprietor	

Entry into the European phase before the European Patent Office

These notes describe the procedural steps required for entry into the European phase before the European Patent Office (EPO). You are advised to read them carefully: failure to take the necessary action in time can lead to your application being deemed withdrawn.

1. The above-mentioned international patent application has been given European application No. **05858097.8**.

2. Applicants **without** a residence or their principal place of business in an EPC contracting state may themselves initiate European processing of their international applications, provided they do so before expiry of the 31st month from the priority date (see also point 6 below).

   During the European phase before the EPO as designated or elected Office, however, such applicants must be represented by a professional representative (Arts. 133(2) and 134(1), (7) EPC).

   Procedural acts performed after expiry of the 31st month by a professional representative who acted during the international phase but is not authorised to act before the EPO have no legal effect and therefore lead to loss of rights.

   Please note that a professional representative authorised to act before the EPO and who acted for the applicant during the international phase does not automatically become the representative for the European phase. Applicants are therefore strongly advised to appoint in good time any representative they wish to initiate the European phase for them; otherwise, the EPO has to send all communications direct to the applicant.

3. Applicants **with** a residence or their principal place of business in an EPC contracting state are not obliged to appoint, for the European phase before the EPO as designated or elected Office, a professional representative authorised to act before the EPO.
   However, in view of the complexity of the procedure it is recommended that they do so.

4. Applicants and professional representatives are also strongly advised to initiate the European phase using EPO Form 1200 (available free of charge from the EPO). This however is not compulsory.

5. **To enter the European phase before the EPO**, the following acts must be performed.
(N.B.: Failure validly to do so will entail loss of rights or other adverse legal consequences.)

5.1 If the EPO is acting as **designated** or **elected** Office (Arts. 22(1)(3) and 39(1) PCT respectively), applicants must, within 31 months from the date of filing or (where applicable) the earliest priority date:

a) Supply a translation of the international application into an EPO official language, if the International Bureau did not publish the application in such a language (Art. 22(1) PCT and R. 107(1)(a) EPC).
If the translation is not filed in time, the international application is deemed withdrawn before the EPO (R. 108(1) EPC).
This loss of rights is deemed not to have occurred if the translation is then filed within a two-month grace period as from notification of an EPO communication, provided a surcharge is paid at the same time (R. 108(3) EPC).

b) Pay the national basic fee (EUR 170,00) and, where a supplementary European search report has to be drawn up, the search fee (EUR 720,00 ; R. 107(1)(c) and (e) EPC).

c) If the time limit under Article 79(2) EPC expires before the 31-month time limit, pay the designation fee (EUR 80,00) for each contracting state designated (R. 107(1)(d) EPC).

d) If the time limit under Article 94(2) EPC expires before the 31-month time limit, file the written request for examination **and** pay the examination fee (EUR 1335,00 ; R. 107(1)(f) EPC).

e) Pay the third-year renewal fee (EUR 400,00) if it falls due before expiry of the 31-month time limit (R. 107(1)(g) EPC).

If the fees under (b) to (d) above are not paid in time, or the written request for examination is not filed in time, the international application is deemed withdrawn before the EPO, or the contracting-state designation(s) in question is (are) deemed withdrawn (R. 108(1) and (2) EPC). However, the fees may still be validly paid within a two-month grace period as from notification of an EPO communication, provided the necessary surcharges are paid at the same time (R. 108(3) EPC). For the renewal fee under (e) above, the grace period is **six** months from the fee's due date (Art. 86(2) EPC).

For an overview of search and examination fees, see OJ EPO 11/2005, 577 and 03/2006.

5.2 If the application documents on which the European grant procedure is to be based comprise more then ten claims, a claims fee is payable within the 31-month time limit under Rule 107(1) EPC for the eleventh and each subsequent claim (R. 110(1) EPC). The fee can however still be paid within a one-month grace period as from notification of an EPO communication pointing out the failure to pay (R. 110(2) EPC).

6. If the applicant had a representative during the application's international phase, the present notes will be sent to the representative, asking him to inform the applicant accordingly.

All subsequent communications will be sent to the applicant, or - if the EPO is informed of his appointment in time - to the applicant's European representative.

7. For more details about time limits and procedural acts before the EPO as designated and elected Office, see the EPO brochure

   How to get a European patent
   Guide for applicants - Part 2
   PCT procedure before the EPO - "Euro-PCT"

   This brochure, the list of professional representatives before the EPO, Form 1200 and details of the latest fees are now all available on the Internet under

   http://www.european-patent-office.org

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Date:	29 November 2006 **at** 09:08
No of pages:	2 *(Inclusive of cover sheet)*

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European Patent Office
Directorate
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Deposit account No
28050065

Patent application / Patent No. (A separate form is required for each applicatio

EP 05858097.8

PCT

001	Filing fee	EUR	170
002	Search fee	EUR	810
005	Designation fee(s)	EUR	560
015	Claims fee(s) (Rule 31 (1) EPC)	EUR	1440
055	Additional copy	EUR	50
006	Examination fee	EUR	1335
007	Fee for grant including fee for printing (up to 35 pages)	EUR	
008	Additional fee for printing (more than 35 pages)	EUR	
033	Renewal fee for the 3rd year	EUR	
034	Renewal fee for the 4th year	EUR	
035	Renewal fee for the 5th year	EUR	
	Extension fee(s) for:	EUR	
		EUR	
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		EUR	
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		EUR	
	Total	EUR	4365

① Payment must be made without charge to the payee. For European Patent Organisation accounts and corresponding currencies of payment see overleaf.

② Debits from deposit accounts with the European Patent Office may only be made in DEM.

③ Payments must be made in the currency of the State in which the EPO account in question is held. Please use the abbreviations for currencies of payment shown overleaf

④ Contracting States should only be specified if they differ from those designed in box 33 of EPO Form 1001 (Request for Grant) or in box V of PCT Form RO/101.

⑤ When extension fees are paid, the States for which they are intended must be specified.

Signature MARKS & CLERK Place, Date 29 November 2006

Received at the EPO on Nov 29, 2006 10:12:36. Page 2 of 2

Eintritt in die europäische Phase (EPA als Bestimmungsamt oder ausgewähltes Amt)

Entry into the European phase (EPO as designated or elected Office)

Entrée dans la phase européenne (l'OEB agissant en qualité d'office désigné ou élu)

Europäische Anmeldenummer oder, falls nicht bekannt, PCT-Aktenzeichen oder PCT-Veröffentlichungsnummer	European application number, or, if not known, PCT application or publication number PCT/US2005/031248	Numéro de dépôt de la demande de brevet européen ou, à défaut, numéro de dépôt PCT ou de publication PCT
Zeichen des Anmelders oder Vertreters (max. 15 Positionen)	Applicant's or representative's reference (max. 15 spaces) DE/P05546EP	Référence du demandeur ou du mandataire (15 caractères ou espaces au maximum)

☒ **1. Anmelder**
Die Angaben über den (die) Anmelder sind in der internationalen Veröffentlichung enthalten oder vom Internationalen Büro nach der internationalen Veröffentlichung vermerkt worden.

☐ Änderungen, die das Internationale Büro noch nicht vermerkt hat, sind auf einem Zusatzblatt angegeben.

Zustellanschrift
(siehe Merkblatt II, #

EPO - DG 1
09 08 2006

1. Applicant
Indications concerning the applicant(s) are contained in the international publication or recorded by the International Bureau after the international publication.

Changes which have not yet been recorded by the International Bureau are set out on an additional sheet.

Address for correspondence
(see Notes II, 1)

1. Demandeur
Les indications concernant le(s) demandeur(s) figurent dans la publication internationale ou ont été enregistrées par le Bureau international après la publication internationale.

Les changements qui n'ont pas encore été enregistrés par le Bureau international sont indiqués sur une feuille additionnelle.

Adresse pour la correspondance
(voir notice II, 1)

2. Vertreter (44)

Name (Nur einen Vertreter angeben, der in das europäische Patentregister eingetragen und an den zugestellt wird)

Geschäftsanschrift

Telefon

Telefax **Telex**

☒ Weitere(r) Vertreter auf Zusatzblatt

2. Representative

Name (Name **only one** representative who will be listed in the Register of European Patents and to whom notification will be made)
EVERY, DAVID AIDAN

Address of place of business
MARKS & CLERK, SUSSEX HOUSE,
83-85 MOSLEY STREET,
MANCHESTER, M2 3LG, UK

Telephone
0161 233 5800

Fax **Telex**
0161 236 5846

Additional representative(s) on additional sheet

2. Mandataire

Nom (N'indiquer **qu' un seul** mandataire, qui sera inscrit au Registre européen des brevets et auquel signification sera faite)

Adresse professionnelle

Téléphone

Téléfax **Télex**

Autre(s) mandataire(s) sur une feuille additionnelle

3. Vollmacht

☐ Einzelvollmacht ist beigefügt.

☐ Allgemeine Vollmacht ist registriert unter Nummer:

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☐ Die beim EPA als PCT-Anmeldeamt eingereichte Vollmacht schließt ausdrücklich die europäische Phase ein.

3. Authorisation

Individual authorisation is attached.

General authorisation has been registered under No:

A general authorisation has been filed, but not yet registered.

The authorisation filed with the EPO as PCT receiving Office expressly includes the European phase.

3. Pouvoir

Un pouvoir spécial est joint.

Un pouvoir général a été enregistré sous le n° :

Un pouvoir général a été déposé, mais n'est pas encore enregistré.

Le pouvoir général déposé à l'OEB agissant en qualité d'office récepteur au titre du PCT s'applique expressément à la phase européenne.

☒ **4. Prüfungsantrag**
Hiermit wird die Prüfung der Anmeldung gemäß Art. 94 EPÜ beantragt. Die Prüfungsgebühr wird (wurde) entrichtet.

Prüfungsantrag in einer zugelassenen Nichtamtssprache (siehe Merkblatt III, 5.2) :

4. Request for examination
Examination of the application under Art. 94 EPC is hereby requested. The examination fee is being (has been, will be) paid.

Request for examination in an admissible non-EPO language (see Notes III, 5.2) :

4. Requête en examen
Il est demandé que soit examinée la demande de brevet conformément à l'art. 94 CBE. Il est (a été, sera) procédé au paiement de la taxe d'examen.

Requête en examen dans une langue non officielle autorisée (voir notice III, 5.2) :

☒ **5. Abschriften**
Zusätzliche Abschrift(en) der im ergänzenden europäischen Recherchenbericht angeführten Schriftstücke wird (werden) beantragt.

Anzahl der **zusätzlichen** Sätze von Abschriften

5. Copies
Additional copy (copies) of the documents cited in the supplementary European search report is (are) requested.

Number of **additional** sets of copies

5. Copies
Prière de fournir une ou plusieurs copies supplémentaires des documents cités dans le rapport complémentaire de recherche européenne.

Nombre de jeux **supplémentaires** de copies

2

6. Für das Verfahren vor dem EPA bestimmte Unterlagen

6.1 Dem Verfahren vor dem EPA als **Bestimmungsamt** (PCT I) sind folgende Unterlagen zugrunde zu legen:

☒ die vom Internationalen Büro **veröffentlichten Anmeldungsunterlagen** (mit **allen** Ansprüchen, Beschreibung und Zeichnungen), gegebenenfalls mit den geänderten Ansprüchen nach Art. 19 PCT

☐ soweit sie nicht ersetzt werden durch die beigefügten **Änderungen.**

Falls nötig, sind Klarstellungen auf einem Zusatzblatt einzureichen!

6.2 Dem Verfahren vor dem EPA als **ausgewähltem Amt** (PCT II) sind folgende Unterlagen zugrunde zu legen:

☒ die dem **internationalen vorläufigen Prüfungsbericht zugrunde gelegten Unterlagen,** einschließlich seiner eventuellen **Anlagen**
(Solche Anlagen müssen immer beigefügt werden)

☐ soweit sie nicht ersetzt werden durch die beigefügten **Änderungen.**

Falls nötig, sind Klarstellungen auf einem Zusatzblatt einzureichen!

☒ Sind dem EPA als mit der internationalen vorläufigen Prüfung beauftragten Behörde **Versuchsberichte** zugegangen, dürfen diese dem Verfahren vor dem EPA zugrunde gelegt werden.

6. Documents intended for proceedings before the EPO

6.1 Proceedings before the EPO as **designated Office** (PCT I) are to be based on the following documents:

the **application documents published** by the International Bureau (with **all** claims, description and drawings), where applicable with amended claims under Art. 19 PCT

unless replaced by the **amendments** enclosed.

Where necessary, clarifications must be submitted on a separate sheet!

6.2 Proceedings before the EPO as **elected Office** (PCT II) are to be based on the following documents:

the **documents on which the international preliminary examination report is based**, including its possible **annexes**
(Such annexes must always be filed)

unless replaced by the **amendments** enclosed.

Where necessary, clarifications must be submitted on a separate sheet!

If the EPO as International Preliminary Examining Authority has received **test reports**, these may be used as the basis of proceedings before the EPO.

6. Pièces destinées à la procédure devant l'OEB

6.1 La procédure devant l'OEB agissant en qualité **d'office désigné** (PCT I) doit se fonder sur les pièces suivantes :

les **pièces de la demande publiée** par le Bureau international (avec **toutes** les revendications, la description et les dessins), éventuellement avec les revendications modifiées conformément à l'article 19 du PCT

dans la mesure où elles ne sont pas remplacées par les **modifications** jointes.

Le cas échéant, des explications doivent être jointes sur une feuille additionnelle!

6.2 La procédure devant l'OEB **agissant en qualité d'office élu** (PCT II) doit se fonder sur les pièces suivantes :

les **pièces sur lesquelles se fonde le rapport d'examen préliminaire international**, y compris ses **annexes** éventuelles
(De telles annexes sont toujours à joindre)

dans la mesure où elles ne sont pas remplacées par les **modifications** jointes.

Le cas échéant, des explications doivent être jointes sur une feuille additionnelle!

Si l'OEB, agissant en qualité d'administration chargée de l'examen préliminaire international, a reçu des **rapports d'essais**, ceux-ci peuvent constituer la base de la procédure devant l'OEB.

7. Übersetzungen
Beigefügt sind die nachfolgend angekreuzten Übersetzungen in einer der Amtssprachen des EPA (Deutsch, Englisch, Französisch):

- *Im Verfahren vor dem EPA als* ***Bestimmungsamt oder ausgewähltem Amt*** *(PCT I + II):*

☐ Übersetzung der **ursprünglich eingereichten internationalen Anmeldung** (Beschreibung, Ansprüche, etwaige Textbestandteile in den Zeichnungen), der veröffentlichten Zusammenfassung, und etwaiger Angaben über biologisches Material nach Regel 13bis.3 und 13bis.4 PCT

☐ Übersetzung der **prioritätsbegründenden Anmeldung(en)**

☐ Es wird hiermit erklärt, daß die internationale Anmeldung in ihrer ursprünglich eingereichten Fassung eine vollständige Übersetzung der früheren Anmeldung ist (Regel 38(5) EPÜ)

- ***Zusätzlich*** *im Verfahren vor dem EPA als* ***Bestimmungsamt*** *(PCT I):*

☐ Übersetzung der nach Art. 19 PCT **geänderten Ansprüche** nebst Erklärung, falls diese dem Verfahren vor dem EPA zugrunde gelegt werden sollen (siehe Feld 6)

- ***Zusätzlich*** *im Verfahren vor dem EPA als* ***ausgewähltem Amt*** *(PCT II):*

☐ Übersetzung der **Anlagen zum internationalen vorläufigen Prüfungsbericht**

7. Translations
Translations in one of the official languages of the EPO (English, French, German) are enclosed as crossed below:

- *In proceedings before the EPO as* ***designated or elected Office*** *(PCT I + II):*

Translation of the **international application** (description, claims, any text in the drawings) **as originally filed**, of the abstract as published and of any indication under Rule 13bis.3 and 13bis.4 PCT regarding biological material

Translation of **the priority application(s)**

It is hereby declared that the international application as originally filed is a complete translation of the previous application (Rule 38(5) EPC)

- ***In addition,*** *in proceedings before the EPO as* ***designated Office*** *(PCT I):*

Translation of **amended claims** and any statement under Art. 19 PCT, if the claims as amended are to form the basis for the proceedings before the EPO (see Section 6)

- ***In addition,*** *in proceedings before the EPO as* ***elected Office*** *(PCT II):*

Translation of any **annexes to the international preliminary examination report**

7. Traductions
Vous trouverez, ci-joint, les traductions cochées ci-après dans l'une des langues officielles de l'OEB (allemand, anglais, français) :

- *Dans la procédure devant l'OEB agissant en qualité d'* ***office désigné ou élu*** *(PCT I + II):*

Traduction de la **demande internationale telle que déposée initialement** (description, revendications, textes figurant éventuellement dans les dessins), de l'abrégé publié, et de toutes indications visées aux règles 13bis.3 et 13bis.4 du PCT concernant le matériel biologique

Traduction de la (des) **demande(s) ouvrant le droit de priorité**

Il est déclaré par la présente que la demande internationale telle que déposée initialement est une traduction intégrale de la demande antérieure (règle 38(5) CBE)

- ***De plus,*** *dans la procédure devant l'OEB agissant en qualité d'* ***office désigné*** *(PCT I) :*

Traduction des **revendications modifiées** et de la déclaration faite conformément à l'article 19 du PCT, si la procédure devant l'OEB doit être fondée sur les revendications modifiées (voir la rubrique 6)

- ***De plus,*** *dans la procédure devant l'OEB agissant en qualité d'* ***office élu*** *(PCT II) :*

Traduction des **annexes du rapport d'examen préliminaire international**

☐ **8. Biologisches Material**
Die Erfindung bezieht sich auf bzw. verwendet biologisches Material, das nach Regel 28 EPÜ hinterlegt worden ist.

☐ Die **Angaben nach Regel 28(1)c) EPÜ** (falls noch nicht bekannt, die Hinterlegungsstelle und das (die) Bezugszeichen (Nummer, Symbole usw.) des Hinterlegers) sind in der internationalen Veröffentlichung oder in der gemäß Feld 7 eingereichten Übersetzung enthalten auf:

Seite(n) / Zeile(n)

Die **Empfangsbescheinigung(en)** der Hinterlegungsstelle

☐ ist (sind) beigefügt

☐ wird (werden) nachgereicht

☐ Verzicht auf die Verpflichtung des Antragstellers nach Regel 28(3) EPÜ auf gesondertem Schriftstück

8. Biological material
The invention relates to and/or uses biological material deposited under Rule 28 EPC.

The **particulars referred to in Rule 28(1)(c) EPC** (if not yet known, the depository institution and the identification reference(s) (number, symbols etc.) of the depositor) are given in the international publication or in the translation submitted under Section 7 on:

page(s) / line(s)

The **receipt(s) of deposit** issued by the depositary institution

is (are) enclosed

will be filed at a later date

Waiver of the right to an undertaking from the requester pursuant to Rule 28(3) EPC attached.

8. Matière biologique
L'invention concerne et/ou utilise de la matière biologique, déposée conformément à la règle 28 CBE.

Les **indications visées à la règle 28(1)c) CBE** (si non encore connues, l'autorité de dépôt et la (les) référence(s) d'identification (numéro ou symboles etc.) du déposant) figurent dans la publication internationale ou dans une traduction produite conformément à la rubrique 7 à la / aux:

page(s) / ligne(s)

Le(s) **récépissé(s) de dépôt** délivré(s) par l'autorité de dépôt

est (sont) joint(s)

sera (seront) produit(s) ultérieurement

Renonciation, sur document distinct, à l'engagement du requérant au titre de la règle 28(3) CBE.

9. Nucleotid- und Aminosäuresequenzen

☐ Die nach Regeln 5.2 und 13ter PCT sowie Regel 111(3) EPÜ erforderlichen Unterlagen liegen dem EPA bereits vor.

☐ Das schriftliche Sequenzprotokoll wird anliegend nachgereicht.

☐ Das Sequenzprotokoll geht nicht über den Inhalt der Anmeldung in der ursprünglich eingereichten Fassung hinaus.

☐ Der vorgeschriebene Datenträger ist beigefügt.

☐ Die auf dem Datenträger gespeicherte Information stimmt mit dem schriftlichen Sequenzprotokoll überein.

9. Nucleotide and amino acid sequences

The items necessary in accordance with Rules 5.2 and 13ter PCT and Rule 111(3) EPC have already been furnished to the EPO.

The written sequence listing is furnished herewith.

The sequence listing does not include matter which goes beyond the content of the application as filed.

The prescribed data carrier is enclosed.

The information recorded on the data carrier is identical to the written sequence listing.

9. Séquences de nucléotides et d'acides aminés

Les pièces requises selon les règles 5.2 et 13ter PCT et la règle 111(3) CBE ont déjà été déposées auprès de l'OEB.

La liste de séquences écrite est produite ci-joint.

La liste de séquences ne contient pas d'éléments s'étendant au-delà du contenu de la demande telle qu'elle a été déposée.

Le support de données prescrit est joint.

L'information figurant sur le support de données est identique à celle que contient la liste de séquences écrite.

10. Benennungsgebühren

☒ 10.1 Es ist derzeit beabsichtigt, den **siebenfachen** Betrag einer Benennungsgebühr zu entrichten. Damit gelten die Benennungsgebühren für **alle Vertragsstaaten des EPÜ**[1] als entrichtet (Art. 2 Nr. 3 GebO), soweit sie **in der internationalen Anmeldung** bestimmt sind[2].

☐ 10.2 Abweichend von der Erklärung in Nr. 10.1 ist derzeit beabsichtigt, **weniger als sieben** Benennungsgebühren für folgende **in der internationalen Anmeldung bestimmte Vertragsstaaten des EPÜ**[2] zu entrichten:

(1) ☐ _____
(2) ☐ _____
(3) ☐ _____
(4) ☐ _____
(5) ☐ _____
(6) ☐ _____

Soweit unter Nr. 10.2 Vertragsstaaten aufgeführt sind, wird beantragt, für die dort nicht aufgeführten Vertragsstaaten von der Zustellung einer Mitteilung nach Regel 108(3) EPÜ abzusehen.

☒ 10.3 Wird ein **automatischer Abbuchungsauftrag** erteilt (Feld 12), so wird das EPA beauftragt, bei Ablauf der Grundfrist nach Regel 107 (1)d) EPÜ den siebenfachen Betrag einer Benennungsgebühr abzubuchen. Ist eine Erklärung nach Nr. 10.2 abgegeben worden, so sollen die Benennungsgebühren nur für die dort angegebenen Vertragsstaaten abgebucht werden, sofern dem EPA nicht bis zum Ablauf der Grundfrist ein anderslautender Auftrag zugeht.

10. Designation fees

10.1 It is currently intended to pay **seven times** the amount of the designation fee. The designation fees for **all the EPC contracting states**[1] **designated in the international application**[2] are thereby deemed to have been paid (Art. 2 No. 3 RFees).

10.2 The declaration in No. 10.1 does not apply. Instead, it is currently intended to pay **fewer than seven** designation fees for the following **EPC contracting states**[2] **designated in the international application**:

If contracting states are indicated under No. 10.2, it is requested that no communication under Rule 108(3) EPC be issued for contracting states not thus indicated.

10.3 If an **automatic debit order** has been issued (Section 12), the EPO is authorised, on expiry of the basic period under Rule 107(1)(d) EPC, to debit seven times the amount of the designation fee. If states are indicated under No. 10.2, the EPO will debit designation fees only for those states, unless instructed otherwise before the basic period expires.

10. Taxes de désignation

10.1 Il est actuellement envisagé de payer un montant correspondant à **sept fois** la taxe de désignation. Les taxes de désignation sont ainsi réputées payées pour **tous les Etats contractants de la CBE**[1] **désignés dans la demande internationale**[2] (art. 2, point 3 du RRT).

10.2 Contrairement à ce qui est indiqué au n° 10.1, il est actuellement envisagé de payer **moins de sept** taxes de désignation pour les **Etats contractants de la CBE**[2] suivants **désignés dans la demande internationale** :

Si des Etats contractants sont mentionnés au n° 10.2, prière de ne pas procéder à la signification d'une notification prévue par la règle 108(3) CBE pour les Etats contractants n'y étant pas mentionnés.

10.3 Si un **ordre de prélèvement automatique** est donné (rubrique 12), il est demandé à l'OEB de prélever, à l'expiration du délai normal visé à la règle 107(1)d) CBE, un montant correspondant à sept fois la taxe de désignation. Si une déclaration a été faite au n° 10.2, les taxes de désignation ne sont à prélever que pour les Etats contractants qui y sont indiqués, sauf instruction contraire reçue par l'OEB avant l'expiration du délai normal.

1 Stand bei Drucklegung: 27 Vertragsstaaten, und zwar: / Status when this form was printed: 27 contracting states, namely / Situation à la date d'impression : 27 Etats contractants, à savoir : **AT** Österreich / Austria / Autriche, **BE** Belgien / Belgium / Belgique, **BG** Bulgarien / Bulgaria / Bulgarie, **CH / LI** Schweiz und Liechtenstein / Switzerland and Liechtenstein / Suisse et Liechtenstein, **CY** Zypern / Cyprus / Chypre, **CZ** Tschechische Republik / Czech Republic / République tchèque, **DE** Deutschland / Germany / Allemagne, **DK** Dänemark / Denmark / Danemark, **EE** Estland / Estonia / Estonie, **ES** Spanien / Spain / Espagne, **FI** Finnland / Finland / Finlande, **FR** Frankreich / France / France, **GB** Vereinigtes Königreich / United Kingdom / Royaume-Uni, **GR** Griechenland / Greece / Grèce, **HU** Ungarn / Hungary / Hongrie, **IE** Irland / Ireland / Irlande, **IT** Italien / Italy / Italie, **LU** Luxemburg / Luxembourg / Luxembourg, **MC** Monaco / Monaco / Monaco, **NL** Niederlande / Netherlands / Pays-Bas, **PT** Portugal / Portugal / Portugal, **RO** Rumänien / Romania / Roumanie, **SE** Schweden / Sweden / Suède, **SI** Slowenien / Slovenia / Slovénie, **SK** Slowakische Republik / Slovak Republic / République slovaque, **TR** Türkei / Turkey / Turquie

2 Für folgende Staaten nur möglich, falls in der internationalen Anmeldung am oder nach folgendem Tag bestimmt: Slowakische Republik, Bulgarien, Tschechische Republik und Estland: 1. Juli 2002, Slowenien: 1. Dezember 2002, Ungarn: 1. Januar 2003 und Rumänien: 1. März 2003. / For the following states this is possible only if they are designated in the international application on or after the stated date: Slovak Republic, Bulgaria, Czech Republic and Estonia: 1 July 2002, Slovenia: 1 December 2002, Hungary: 1 January 2003 and Romania: 1 March 2003. / En ce qui concerne les Etats suivants seulement si la désignation a été effectuée dans la demande internationale à la date suivante ou à une date ultérieure: République slovaque, Bulgarie, République tchèque et Estonie: 1er juillet 2002, Slovénie: 1er décembre 2002, Hongrie: 1er janvier 2003 et Roumanie: 1er mars 2003.

☒ **11. Erstreckung des europäischen Patents**
Bei Zahlung der Erstreckungsgebühr(en) gilt diese Anmeldung auch als wirksamer Erstreckungsantrag für die in der internationalen Anmeldung bestimmten »Erstreckungsstaaten«. Es ist beabsichtigt, diese Gebühr(en) für folgende Staaten zu entrichten:

11. Extension of the European patent
On payment of the extension fee(s) this application is also deemed to be a request for extension to all the "extension states" designated in the international application. It is intended to pay the fee(s) for the following states:

11. Extension des effets du brevet européen
La taxe (Les taxes) d'extension payée(s), la présente demande est également réputée être une demande d'extension à tous les «Etats autorisant l'extension» désignés dans la demande internationale. Il est envisagé de payer la taxe (les taxes) d'extension pour les Etats suivants:

☐	SI	Slowenien [1]	Slovenia [1]	Slovénie [1]
☐	LT	Litauen	Lithuania	Lituanie
☐	LV	Lettland	Latvia	Lettonie
☐	AL	Albanien	Albania	Albanie
☐	RO	Rumänien [1]	Romania [1]	Roumanie [1]
☐	MK	Ehemalige jugoslawische Republik Mazedonien	Former Yugoslav Republic of Macedonia	Ex-République yougoslave de Macédoine
☐	____	_____ [2]	_____ [2]	_____ [2]

1) Für Slowenien und Rumänien nur möglich, falls in der internationalen Anmeldung bis 30. November 2002 (Slowenien) oder bis 28. Februar 2003 (Rumänien) bestimmt. / For Slovenia and Romania this is possible only if they are designated in the international application up to 30 November 2002 (Slovenia) or 28 February 2003 (Romania). / En ce qui concerne la Slovénie et la Roumanie, seulement si la désignation a été effectuée dans la demande internationale jusqu'au 30 novembre 2002 (Slovénie) ou jusqu'au 28 février 2003 (Roumanie).

2) Platz für Staaten, mit denen »Erstreckungsabkommen« nach Drucklegung dieses Formblatts in Kraft treten und die in der internationalen Anmeldung bestimmt waren. / Space for States with which "extension agreements" enter into force after this form has been printed and which were designated in the international application. / Prévu pour des Etats à l'égard desquels des «accords d'extension» entreront en vigueur après l'impression du présent formulaire et qui ont été désignés dans la demande internationale.

12. Automatischer Abbuchungsauftrag ***(Nur möglich für Inhaber von beim EPA geführten laufenden Konten)***

☐ Das EPA wird beauftragt, nach Maßgabe der Vorschriften über das automatische Abbuchungsverfahren fällige Gebühren und Auslagen vom untenstehenden laufenden Konto abzubuchen. In Bezug auf die **Benennungsgebühren** wird auf Feld 10.3 verwiesen. Das EPA wird ferner beauftragt, die **Erstreckungsgebühren** für jeden in Feld 11 angekreuzten »Erstreckungsstaat« bei Ablauf der Grundfrist zu ihrer Zahlung abzubuchen, sofern ihm nicht bis dahin ein anderslautender Auftrag zugeht.

Nummer und Kontoinhaber

12. Automatic debit order ***(for EPO deposit account holders only)***

The EPO is hereby authorised, under the Arrangements for the automatic debiting procedure, to debit from the deposit account below any fees and costs falling due. For **designation fees**, see Section 10.3. The EPO is also authorised, on expiry of the basic period for paying the **extension fees**, to debit those fees for each of the "extension states" marked with a cross in Section 11, unless instructed otherwise before the said period expires.

Number and account holder

12. Ordre de prélèvement automatique ***(uniquement possible pour les titulaires de comptes courants ouverts auprès de l'OEB)***

Par la présente, il est demandé à l'OEB de prélever du compte courant ci-dessous les taxes et frais venant à échéance, conformément à la réglementation relative au prélèvement automatique. Pour les **taxes de désignation,** se reporter à la rubrique 10.3. Il est en outre demandé à l'OEB de prélever, à l'expiration du délai normal prévu pour leur paiement, les **taxes d'extension** pour chaque «Etat autorisant l'extension» coché à la rubrique 11, sauf instruction contraire reçue avant l'expiration de ce délai.

Numéro et titulaire du compte

☐ **13.** Eventuelle **Rückzahlungen** auf das beim EPA geführte laufende Konto

Nummer und Kontoinhaber

13. Any **reimbursement** to EPO deposit account

Number and account holder

13. Remboursements éventuels à effectuer sur le compte courant ouvert auprès de l'OEB

Numéro et titulaire du compte

14. Unterschrift(en) des (der) Anmelder(s) oder Vertreters

Ort / Datum

Für Angestellte (Art. 133(3) EPÜ) mit allgemeiner Vollmacht:

Nr.

Name(n) des (der) Unterzeichneten bitte in Druckschrift wiederholen. Bei juristischen Personen bitte auch die Stellung des (der) Unterzeichneten innerhalb der Gesellschaft in Druckschrift angeben.

14. Signature(s) of applicant(s) or representative

EVERY, DAVID AIDAN

Place / Date Manchester, UK - 07/08/06

For employees (Art. 133(3) EPC) having a general authorisation:

No.

Please print name(s) under signature(s). In the case of legal persons, the position of the signatory within the company should also be printed.

14. Signature(s) du (des) demandeur(s) ou du mandataire

Lieu / Date

Pour les employés (art. 133(3) CBE) disposant d'un pouvoir général :

N°

Le ou les noms des signataires doivent être indiqués en caractères d'imprimerie. S'il s'agit d'une personne morale, la position occupée au sein de celle-ci par le ou les signataires doit également être indiquée en caractères d'imprimerie.

ADDITIONAL REPRESENTATIVES

ARMSTRONG, IAIN CHESHIRE

ATKINSON, PETER BIRCH

BANFORD, PAUL CLIFFORD

HODKINSON, KEITH LEONARD

HOLMES, MATTHEW PETER

JENKINS, RICHARD GAVIN

KENRICK, MARK LLOYD

LEES, KATE JANE

LYONS, ANDREW JOHN

PARKINSON, NEIL SCOTT

ROBERTS, PETER DAVID

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.....
EVERY, DAVID AIDAN

7th August 2006

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EPO - DG 1

09 08 2006

(44)

European Patent Office
The Hague
P.O. Box 5818
Patentlaan 2
2280 HV Rijswijk
Netherlands

Your Ref:

Our Ref: DE/HS/P05546EP

Date: 07th August 2006

Dear Sirs,

Re: **European Patent Application No. (not yet designated)**
Derived from PCT/US2005/031248
Applicant: VULCAN LEAD, INC

We enclose Form 1200 for entering the European Phase of the above PCT application (due 1st March 2008), together with a copy of the PCT specification as filed.

Yours faithfully,

MARKS & CLERK

093144-9030 EP

SHIELDED DEVICE CONTAINMENT VESSEL

BACKGROUND

[0001] The present invention relates to a shielded device containment vessel for storing, transporting and detonating an explosive device and method of operating the same.

[0002] Bomb containment vessels are used for transporting and storing explosives, as well as containing an explosion. Typically, containment vessels are spherical or rectangular units having an external shell and a series of reinforcements and shock absorbing material between the shells. Containment vessels contain and absorb an explosion, accidental or intentional, to prevent damage to surrounding persons, environment, or structures. However, if radioactive explosives are stored or detonated within the containment vessel, the containment vessel does not prevent dispersal of radiation from the vessel. Thus, the containment vessel provides no protection to surrounding persons, environment, or structures from radiation exposure.

SUMMARY

[0003] In one embodiment, the invention provides a radiation shield including a plurality of panels formed of a radiation shielding material. The panels are shaped to complement a contour of a vessel and the panels are arranged proximate a portion of the vessel. A plurality of seam plates are positioned along a seam between adjacent panels and each seam plate overlaps adjacent panels.

[0004] In another embodiment, the invention provides a device containment apparatus comprising a vessel for storing a radioactive explosive device. The vessel includes an outer wall defining an interior area. A shield formed of radiation shielding material is positioned adjacent the vessel for minimizing dispersal of radioactive material from the interior area of the vessel.

[0005] In yet another embodiment, the invention provides a device containment apparatus for storing an explosive device and minimizing dispersal of radioactive material. The device containment apparatus includes a vessel including an outer wall defining an interior area, an opening through the outer wall for accessing the interior area, and a door providing access to the interior area of the vessel. A radiation shield formed of a radiation shielding material is positioned adjacent to a portion of the vessel.

[0006] In another embodiment the invention provides a method of using a device containment vessel to reduce exposure to radioactive material. The method includes providing a device containment vessel having an outer wall defining an interior area, an opening through the outer wall for accessing the interior area, and a door providing access to the interior are of the vessel. The method further includes positioning a shield adjacent the outer wall of the vessel, the shield being formed of a radiation shielding material, and placing an explosive device containing radioactive material in the interior area of the device containment vessel wherein the shield minimizes dispersal of radiation from the explosive device.

[0007] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a perspective view of one embodiment of a device containment apparatus embodying the invention.

[0009] Figs. 2-5 are perspective views of a partial assembly of the device containment apparatus of Fig. 1.

[0010] Fig. 6 is a section view of the radiation shield taken along line 6--6 of Fig. 2.

[0011] Fig. 7 is a perspective view of another embodiment of a device containment apparatus embodying the invention.

[0012] Fig. 8 is a perspective view of a partial assembly of the device containment apparatus of Fig. 6, showing a plate member.

[0013] Fig. 9 is a perspective view of a partial assembly of the device containment apparatus of Fig. 6, showing a plurality of plate members.

[0014] Fig. 10 is an end view of a device containment apparatus illustrating an internal radiation shield.

[0015] Fig. 11 is a section view of the device containment apparatus of Fig. 10 taken along line 11--11.

[0016] Fig. 12 is a perspective view of another embodiment of the device containment apparatus including a supplemental radiation shield.

[0017] Fig. 13 is a perspective view of another embodiment of the device containment apparatus including a supplemental radiation shield.

[0018] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings.

DETAILED DESCRIPTION

[0019] Figs. 1-5 illustrate a shielded containment system 20 according to one embodiment of the present invention. The shielded containment system 20 is especially suitable for use in the safe disposal and transportation of hazardous materials, including explosive devices (e.g., bombs) and materials, toxic materials, poisonous materials, radioactive materials, biological agents, and chemical agents, and objects having or expected of having one or more such hazardous materials. In a preferred embodiment, the shielded containment system 20 is used for transporting, storing, and/or detonating explosive radioactive materials.

[0020] The shielded containment system 20 includes a device containment vessel 24 and a radiation shielding system 26. The containment vessel 24 includes an outer wall 28 (Fig. 2), which at least partially encloses an interior area 32 for receiving explosive devices or materials. In the illustrated embodiment, the containment vessel 24 has a substantially spherical shape. The containment vessel 24 includes an opening 36 through the outer wall 28 for accessing the interior area 32 and a door frame 40, which substantially surrounds the opening 36. The door frame 40 supports a door 44 for movement relative to the door frame 40 between an open position (Fig. 1), in which the door 44 is moved away from or out of the opening 36, and a closed position (Fig. 5), preventing access to the interior area 32 through the opening 36. In one embodiment, the containment vessel 24 includes a latch for securing the door 44 in the closed position and a lock to further secure the door 44 in the closed position and to prevent or limit unauthorized access to the interior area 32. One example of a containment vessel used in the present invention is the Model 42-SCS manufactured by Nabco, Inc. (Pittsburgh, Pennsylvania).

[0021] In the illustrated embodiment, the containment vessel 24 is supported by and mounted to a support frame 48 that includes a base 52. Portions of the containment vessel 24 and the radiation shielding system 26 are coupled to and supported by the base 52, and in the illustrated embodiment the underside or bottom portion 56 of the containment vessel 24 is coupled to the base 52 by mounting brackets 54 (Figs. 2 and 3). The support frame 48 supports the containment vessel 24 in an elevated position above the ground or the floor so that a hand cart, dolly, forklift, or other carrier may more easily lift the containment vessel 24 off of the ground or the floor and move the containment vessel 24 from a first location to a

second, remote location. In these embodiments, the support frame 48 may provide openings for receiving portions of a hand cart, dolly, forklift, or other carrier (described below) to facilitate movement of the containment vessel 24.

[0022] In another embodiment, the support frame 48 includes a number of wheels or rollers connected to the support frame 48 to facilitate movement of the containment vessel 24 between locations. For example, the support frame 48 may be structured as a trailer so that an operator or a carrier can transport the containment vessel 24 more easily between locations. In some embodiments, the containment vessel 24 may include a dedicated carrier or other non-dedicated carriers may be operable to move the containment vessel 24.

[0023] As shown in Figs. 1 and 2, the radiation shielding system 26 provides a barrier to prevent or minimize dispersal of radiation from radioactive materials stored or detonated within the containment vessel 24 to the surrounding environment In the illustrated embodiment, the radiation shielding system 26 includes a main vessel shield 60, a door shield system 116, corner shields 196, and auxiliary shield panels 208 (discussed below). The main vessel shield 60 includes a plurality of panels 64 formed of radiation shielding material (Figs. 2, 3 and 6). Each panel is shaped to complement a contour of the spherical containment vessel 24 and in particular, a portion of the containment vessel 24 adjacent where the panel 64 is positioned. In the illustrated embodiment, the shape of the panels 64 positioned adjacent the door frame 40 is modified to fit around the door frame 40.

[0024] As shown in Fig. 2, each panel 64 includes a first end 68, a second end 72 and first and second side edges 76, 80. The panels 64 are arranged about a circumference of the containment vessel 24 such that the first side edge 76 and the second side edge 80 of adjacent panels 64 abut The first end 68 of the panel 64 is coupled to the base 52 or the bottom portion 56 of the containment vessel 24, and the second end 72 of the panel 64 is coupled to a top portion 84 of the containment vessel 24. For example, the panels 64 may be mounted to fasteners 86 attached to the containment vessel 24, coupled to the containment vessel 24 at attachment points (not shown) welded to the outer wall 28, or the like. In one embodiment, there is an air gap between the outer wall 28 of the containment vessel 24 and the panels 64 to provide a tolerance between the two.

[0025] The main vessel shield 60 also includes a plurality of seam plates 88 (Figs. 3-5). Each seam plate 88 is positioned over a seam (not shown) between adjacent panels 64 and is

coupled to the adjacent panels 64. The seam plates 88 are shaped to complement the contour of the adjacent panels 64 and the spherical containment vessel 24. The seam plate 88 overlaps the adjacent panels 64 to prevent line-of-sight radiation exposure, or exposure to other hazardous materials, from the containment vessel 24 at the seam. As shown in Fig. 4, fasteners 96 are attached to each panel 64 and the seam plate 88 includes U-shaped brackets 100 for sliding engagement with the fasteners 96. It should be readily apparent to those of skill in the art that other fastener means may be used to couple the seam plates 88 to the panels 64.

[0026] Fig. 6 is a section view of a panel 64 of the main vessel shield 60 that shows multiple layers and materials forming the panel 64. In the illustrated embodiment, the panel 64 is formed from two layers of stainless steel plating 104, 108 that are formed or molded around a radiation shielding core 112. In some embodiments, the core 112 includes or is formed from lead. However, in other embodiments, the core 112 includes or is formed from other radiation shielding materials, such as tungsten. The seam plate 88 is formed from two layers of stainless steel plating formed or molded around a radiation shielding core as well.

[0027] The radiation shielding core 112 has a thickness sufficient to contain radiation in the interior area 32 of the containment vessel 24 and prevent radiation or hazardous materials dispersal to the atmosphere. In one embodiment, the core 112 has a thickness of about 0.25 to about 0.8 inches, however, it should be readily apparent to one of skill in the art that the thickness of the core 112 is proportional to the level of shielding required.

[0028] In other embodiments, the main vessel shield 60 is manufactured from or includes other materials, including plastics, other synthetic materials, ceramics, fiberglass, iron, and the like, which comprise a radiation shielding material or encase a radiation shielding core. In these embodiments, the main vessel shield 60 is molded (e.g., injection molded) from a plastic material or the main vessel shield 60 is manufactured in any other manner, such as by casting, stamping, machining, bending, pressing, extruding, or other manufacturing operations. In still another embodiment, the radiation shielding core 112 is coated with a protective layer, such as plastic, ceramic, or other synthetic materials. In addition, the main vessel shield may be formed from at least one lead wool blanket, which may be encased, that is positioned adjacent the containment vessel 24.

[0029] In embodiments such as the illustrated embodiment of Figs. 1-5 having stainless steel plating and a core, the steel plating absorbs and contains explosions, minimizing the potential dangers of objects contained in the interior area 32. The steel plating also protects objects contained in the interior 32 area from impacts and environmental damage during storage and transportation of the objects. In these embodiments, the core 112 operates to absorb and contain explosions and to protect the environment external to the containment vessel 24 from hazardous materials within the interior area 32, including radiation. The core 112 also provides radiological insulation to contain or minimize the dispersion of potential harmful radiological or nuclear materials contained in the interior area 32, during transport, storage or detonation of the explosives.

[0030] In embodiments having multiple layers and/or being formed of multiple sheets, the layers and/or sheets are welded together. Alternatively, the layers and/or sheets are secured together by threaded fasteners, rivets, pins, clamps, or other fasteners, by snap fits, inter-engaging elements, adhesive or cohesive bonding material, by brazing, or soldering, and the like. In one embodiment, the main vessel shield 60 is formed from a single continuous sheet rather than multiple panels and seam plates.

[0031] In some embodiments, the main vessel shield 60 includes a seal including radiation shielding material, which is positioned between the shield 60 and the outer wall 28 of the containment vessel 24 to prevent radiological materials or other hazardous materials from leaking out of the interior area 32 between the shield 60 and the outer wall 28. In these embodiments, the seal can include interlocking or overlapping protrusions, panels, or tabs. In other embodiments, the seal can include one or more elastic and/or insulating elements positioned between the shield 60 and the outer wall 28 of the containment vessel 24.

[0032] As can be seen in Figs. 2-4, the panels 64 are arranged such that the top portion 84 and the bottom portion 56 of the containment vessel 24 remain exposed, which does reduce the weight of the radiation shielding system 26. It should be readily apparent to one of skill in the art that in further embodiments no portions of the containment vessel 24 are exposed, either the top or bottom portion 84, 56 is exposed, or other portions of the containment vessel 24 may be exposed. For example, in one embodiment, radiation shielding panels are positioned at the top and bottom exposed portions 84, 56 of the containment vessel 24 to completely enclose the containment vessel 24.

[0033] As shown in Figs. 1, 4 and 5, the radiation shielding system 26 includes a door shield system for containing and minimizing radiation emissions from the interior area 32 of the containment vessel 24 at areas adjacent the opening 36, the door frame 40 and the door 44. The door shield system includes a pair of radiation shielding frame sleeves 120, 124 configured and adapted for covering external surfaces of the door frame 40. In Fig. 4, frame sleeve 120 is shown attached to the door frame 40 and frame sleeve 124 is shown detached from the door frame 40. The frame sleeves 120, 124 are attached to the door frame 40 with threaded fasteners 128, however, it should be readily apparent that other fastener means may be used, such as rivets, pins, clamps, or other fasteners, by snap fits, inter-engaging elements, adhesive or cohesive bonding material, by brazing, or soldering, and the like.

[0034] Each frame sleeve 120, 124 is formed or molded to complement the contour of the door frame 40. The frame sleeves 120, 124 cover, or encase, external surfaces of the door frame 40 to contain or minimize radiation within the interior area 32 from traveling to the external environment through the door frame 40 or areas between the door frame 40 and the adjacent panels 64. As shown in Figs. 4 and 5, the frame sleeves 120, 124 overlap a portion of the adjacent panels 64 to prevent line-of-sight radiation exposure from between the door frame 40 and the panel 64. In a further embodiment, the frame sleeves 120, 124 include fewer of more components, for example, a single sleeve is configured for covering the door frame 40.

[0035] In the closed position, the door 44 is received by the opening to prevent access to the interior area 32. As shown in Fig. 5, an arm 132 pivotally connected to the support frame 42 supports the door 44 and a pair of brackets 136 connect the door 44 to the arm 132. The door shield system includes a door shield 140 for covering an external surface of the door 44, and preventing or minimizing radiation emissions from the interior area 32 of the containment vessel 24 through the door 44 and a seam 144 between the door 44 and the door frame 40. The door shield 140 has a size sufficient to cover the door 44 and the door frame 40 of the containment vessel 24.

[0036] The door shield 140 includes a pair of substantially semi-circular shield portions 148, 152 that are coupled to the door 44 of the containment vessel 24. Each shield portion 148, 152 includes a pair of notches 156 such that when the door shield 140 is attached to the door 44, the notches 156 fit around the brackets 136. Further, each shield portion 148, 152 includes a radially extending flange 148A, 152A positioned to cover a seam between the two

frame sleeves 120, 124 coupled to the door frame 40. Each shield portion 148, 152 includes an inner band 148B, 152B spaced radially inward from an outer perimeter 148C, 152C of the respective shield portion 148, 152. The inner bands 148B, 152B and the outer perimeters 148C, 152C fit between an inner edge of the door frame 40 and an outer edge of the door frame to prevent line-of-sight radiation through the door frame 40. In the illustrated embodiment, the lower shield portion 148 includes a flange 160 for covering a seam between the two door shield portions 148, 152. In a further embodiment, the door 44 is formed from a radiation shielding material, such as tungsten, lead or the like, therefore, eliminating the need for a door shield, although supplemental shields may be used to provide shielding at seams of the containment vessel 24.

[0037] The door shield system also includes an upper shield 172, a lower shield 176 and a door mount shield 180. As shown in Fig. 4, the upper shield 172 is positioned over an upper exposed area 184 of the containment vessel 24 behind a top portion of the door frame 40 and between the two panels 64 positioned adjacent the door frame 40. The upper shield 172 prevents or minimizes radiation dispersal to the external environment through the upper exposed area 184. The upper shield 172 attaches to the outer wall 28 of the containment vessel 24. It should be readily apparent to those of skill in the art that other upper shield configurations may be used to cover the exposed area 184 behind the door frame 40 and between the two panels 64 positioned adjacent the door frame 40.

[0038] As shown in Fig. 4, the lower shield 176 includes a first shield portion 188 and a second shield portion 190 positioned over a lower exposed area (not shown) at the bottom portion 56 of the containment vessel 24 and between the panels 64 positioned adjacent the door frame 40. The first shield portion 188 of the lower shield 176 extends between and is coupled to two front corner shields 196 (discussed below). The first shield portion 188 covers a portion of the exposed area behind a bottom portion of the door frame 40 and between the two front corner shields 196. The second shield portion 192 is coupled to the first shield portion 188 and extends downward from the first shield portion 188 (Fig. 4) and over a portion of a front face 200 of the base 52. The second shield portion 192 covers a portion of the exposed area behind the bottom portion of the door frame 40 and between the first shield portion 188 and the base 52. It should be readily apparent to those of skill in the art that other lower shield configurations may be used to cover the exposed area behind the door frame 40 and between the two panels 64 positioned adjacent the door frame 40. For

example, in one embodiment a radiation shielding plate is mounted to the front face 200 of the base 52.

[0039] As illustrated by Figs. 1 and 5, the door mount shield 180 encloses the door brackets 136 and a portion of the arm 132 to prevent or minimize radiation emissions from the interior area 32 through seams between the door shield portions 148, 152 and the brackets 136. It should be readily apparent to those of skill in the art that the door mount shield 180 may include any number of shield portions.

[0040] In a preferred embodiment, the shield portions of the door shield system are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the shield portions are formed from any number of the materials and layers discussed above with respect to the main vessel shield 60.

[0041] As illustrated in Figs. 1, 4 and 5, the radiation shielding system 26 includes four corner shields 196 for preventing or minimizing radiation emissions from the containment vessel 24 through openings where the containment vessel 24 is attached to the base 52. As seen in Figs. 2 and 3, the containment vessel 24 is attached to the base 52 by mounting brackets 54. The panels 64 of the main vessel shield 60 are configured to fit around the mounting brackets 54, which leaves openings to the outer wall 28 of the containment vessel 24. Each corner shield 196 is positioned to cover one mounting bracket 54 and overlap the adjacent panels 64. Although the mounting brackets 54 and corner shields 196 are positioned in the four corners of the base 52, in further embodiments, fewer or more mounting brackets 54 and corner shields 196 may be used and positioned in alternate positions around the circumference of the containment vessel 24. In a preferred embodiment, the corner shields 196 are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the corner shields 196 are formed from any number of the materials and layers discussed above with respect to the main vessel shield 60.

[0042] As shown in Fig. 1, the radiation shielding system 26 includes auxiliary shield panels 208 mounted to the support frame 48 of the containment vessel 24. The auxiliary shield panels 208 prevent or minimize radiation emissions from radioactive materials within the interior area 32 of the containment vessel 24 through a seam between the panels 64 of the main vessel shield 60 and the frame sleeves 120, 124 of the door shield system 116. Each auxiliary shield panel 208 is mounted to the support frame 48 and extends between an upper

frame portion 212 to the base 52 adjacent an exposed area to be covered. In a preferred embodiment, the auxiliary shield panels 208 are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the auxiliary shield panels 208 are formed from any number of the materials and layers discussed above with respect to the main vessel shield 60.

[0043] Figs. 7-9 illustrate another embodiment of a shielded containment system 220 embodying the invention, in which like features with the embodiment shown in Figs.1–5 are identified by the same numerals. The shielded containment system 220 includes the device containment vessel 24 and a radiation shielding system. The containment vessel 24 is supported by and mounted to the support frame 48 that includes the base 52. The containment vessel 24 includes the outer wall 28, which at least partially encloses an interior area (not shown) for receiving explosive materials. In the illustrated embodiment, the containment vessel 24 has a substantially spherical shape. The containment vessel 24 includes the opening 36 through the outer wall 28 for accessing the interior area and the door frame 40, which substantially surrounds the opening 36. The door frame 40 supports the door 44 for movement relative to the door frame 40 between an open position in which the door 44 is moved away from or out of the opening 36, and a closed position (shown in Fig. 7), preventing access to the interior area through the opening 36.

[0044] The radiation shielding system includes a main vessel shield 224, a door frame shield 228 and a door shield 232. The main vessel shield 224 includes a plurality of panels 236 and a pair of frame rings 240, 242 mounted to the containment vessel 24 for coupling the panels 236 thereto. Figs. 8 and 9 illustrate construction of the main vessel shield 224. The panels 236 are shaped to complement a contour of the spherical containment vessel 24. Each panel 236 includes a first end 244, a second end 248 and first and second side edges 252, 256. The first end 244 of the panel 236 is coupled to the upper frame ring 240 and the second end 248 of the panel 236 is coupled to the lower frame ring 242. The panels 236 are arranged about a circumference of the containment vessel 24 such that the first edge 252 and the second edge 256 of adjacent panels 236 abut.

[0045] Each panel 236 includes a seam plate 260 extending laterally from a top surface 264 of the second edge 256 of the panel 236. The seam plate 260 overlaps the first edge 252 of he adjacent panel 236 and is positioned over a seam 268 between adjacent panels 236. The seam plate 260 prevents line-of-sight radiation dispersal, or dispersal of other hazardous

materials, from the containment vessel 24 at the seam 268. In the illustrated embodiment, the seam plate 260 is integrated with the second edge 256 of the panel 236, however, those skilled in the art will recognize that in further embodiments, the seam plate 260 may be a separate piece.

[0046] The radiation shielding system includes the door frame shield 228 that absorbs and contains radiation emissions from the interior area of the containment vessel 24 at areas adjacent the opening 36 and the door frame 40 that are not protected by the main vessel shield 224. The door frame shield 228 includes a substantially rectangular plate 272 shaped to complement a contour of the containment vessel 24, and having an opening 276 configured to fit around and abut the door frame 40.

[0047] In the illustrated embodiment, the door shield 232 is coupled to the arm 132 of the containment vessel 24 and covers an exterior surface of the door 44 to prevent or minimize radiation emissions from the interior area of the containment vessel 24 at the door and the door frame 40. The door 44 shield 232 has a size sufficient to cover the door 44 and the door frame 40 of the containment vessel 24. In a further embodiment, the door shield 232 is attached directly to the door 44 or the door itself is formed of a radiation shielding material.

[0048] As seen in Figs. 7 and 9, the radiation shield system keeps exposed the top portion 84 and a bottom portion (not shown) of the containment vessel 24. It should be readily apparent to one of skill in the art that in further embodiments no portions of the containment vessel 24 will be exposed or other portions may be exposed. For example, in one embodiment, radiation shielding panels are positioned at the exposed portions of the containment vessel 24.

[0049] In a preferred embodiment, each shield component of the radiation shielding system is formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the shield components may be formed from any number of materials and layers discussed above with respect to Figs. 1-5.

[0050] In a preferred embodiment, the shielded containment systems discussed above are factory fabricated and assembled. However, on one embodiment, the radiation shield system is field fabricated and attached to the containment vessel.

[0051] Figs. 10 and 11 illustrate an interior radiation shielding system 320 for a containment vessel 324 having a similar construction to the containment vessel 24 shown in Figs. 1-5. The radiation shielding system 320 is positioned adjacent an interior surface 328 of an outer wall 332 of the containment vessel 324. The radiation shielding system 320 includes a plurality of radiation shielding panels 336 shaped to complement an internal contour of the spherical containment vessel 324. Each panel 336 includes a first end 340, a second end 344, and first and second side edges 348, 352. The first end 340 of each panel 336 is coupled to the containment vessel 324 adjacent a door opening 356, and the second end 344 is coupled to a rear portion of the containment vessel 324. A radiation shielding end cap 364 is coupled to the containment vessel 324 at the rear portion 360 to cover an open area at the second ends 344 of the panels 336. In the illustrated embodiment, the panels 336 are configured and arranged in a horizontal direction, however, in a further embodiment the panels 336 may be configured and arranged in another direction, such as vertical.

[0052] The panels 336 are arranged about the interior circumference of the containment vessel 324 such that the first edge 348 and the second edge 352 of adjacent panels 336 abut. A seam 368 between adjacent panels 336 are tack welded together, however, the panels 336 may also be attached at the seams 368 by other mechanical fastener means known in the art In a further embodiment, seam plates (not shown) are positioned over each seam 368 between adjacent panels 336 to overlap adjacent panels 336 and prevent or minimize line-of-sight radiation dispersal, or dispersal of other hazardous materials, from the containment vessel at the seam 368. In this embodiment, at least a door shield (not shown) would be required to contain radiation in the interior area at the opening 356 of the containment vessel 324.

[0053] In one embodiment, the interior radiation shielding system 320 is fabricated and assembled prior to assembly of the containment vessel 324. For example, the containment vessel 324 is formed from two halves of pressed steel welded together to form a sphere. To assemble the radiation shielding system 320, the panels 336 and seam plates are positioned and arranged in each half of the vessel prior to vessel assembly. After the radiation shielding system 320 is assembled, the two halves of the containment vessel 324 are coupled together. The radiation shielding system 320 is incompressible, and after assembly of the containment vessel 324, an explosive is detonated within the interior area to tightly press the panels 336 to the outer wall 332 of the containment vessel 324.

[0054] In a preferred embodiment, the panels 336 and other components of the interior radiation shield system 320 are formed by welding together two layers of stainless steel plating with a radiation shielding core therebetween. Alternatively, the panels 336 may be formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the panels 336 and other components of the radiation shielding system 320 may be formed from any number of materials and layers discussed above with respect to Figs. 1-5.

[0055] Figs. 12 and 13 illustrate the shielded containment system 220 of Fig. 7 including a supplemental radiation shield. The supplemental radiation shield is attached to the containment vessel 24 or the support frame 48 as needed to provide additional protection against radiation dispersed from the containment vessel 24. For example, when hazardous materials having greater radioactive properties are stored in the containment vessel 24, the supplemental radiation shield is used in addition to the radiation shielding system discussed above. The supplemental radiation shield is either factory mounted to the containment vessel 24, or added on in the field as needed.

[0056] Fig. 12 illustrates one embodiment of a supplemental radiation shield 420 including radiation shielding blankets mounted to the upper frame ring 240 of the radiation shielding system and covering the panels 236. In the illustrated embodiment, the supplemental radiation shield comprises multiple blankets, however, in further embodiments the supplemental radiation shield comprises a single blanket arranged around the containment vessel. In a preferred embodiment, the blankets 420 are formed from lead wool rope and are encased in a nylon reinforced PVC covering. It should be readily apparent to those of skill in the art that other radiation shielding materials may be used to form the blankets 420, other materials for the blanket covering may be used, or the covering may be eliminated.

[0057] Hooks 424 are hung from the upper frame ring 240 for supporting the blankets 420, although in a further embodiment other fasteners may be used to attach the blankets 420 to the radiation shielding system. In another embodiment, the supplemental radiation shield 420 includes a plurality of radiation shielding panels coupled to the frame rings 240, 242 and covering the panels 236 of the radiation shielding system.

[0058] Fig. 13 illustrates another embodiment of the supplemental radiation shield 520 including a plurality of radiation shielding panels 524 mounted to the support frame 48 of the

containment vessel 24 and substantially surrounding the containment vessel 24. Each panel 524 includes a first end 528, a second end 532, and first and second side edges 536, 540. The first end 528 of the panel 524 is coupled to the upper portion 212 of the support frame 48 and the second end 532 of the panel 524 extends to the base 52. The panels 524 are arranged about a periphery of the support frame 48 such that the first edge 536 and the second edge 540 of adjacent panels 524 abut.

[0059] The second edge 540 of each panel 524 includes a seam plate 544 extending laterally from a top surface of the second edge 540 of the panel 524. When the panels 524 are attached to the support frame 48 and positioned adjacent each other, the seam plate 544 is positioned over a seam 552 between adjacent panels 524 and overlaps the first edge 536 of the adjacent panel 524. The seam plate 544 prevents line-of-sight radiation dispersal, or dispersal of other hazardous materials, from the containment vessel at the seam 552. In the illustrated embodiment, the seam plate 544 is integrated with the second edge of the panel, however, those of skill the art will recognize that in further embodiments, the seam plate 544 may be a separate piece.

[0060] In a preferred embodiment, the panels 524 of the supplemental radiation shield system 520 are formed by a radiation shielding core encased within stainless steel plating. In further embodiments, the panels 524 may be formed from any number of materials and layers discussed above with respect to Figs. 1-5. For example, the panels 524 may each be formed from a lead wool blanket, as shown in Fig. 12, or a single lead wool blanket may be mounted to the support frame 48.

[0061] In another embodiment of the radiation shielding system, the shielded containment vessel includes either the supplemental radiation shields shown in Figs. 12 and 13 as a primary vessel shield, but does not include the main vessel shield, i.e. the plurality of panels, attached to the containment vessel. In this embodiment, the supplemental radiation shield has a thickness sufficient to prevent or minimize radiation emissions from the interior area of the containment vessel. In yet another embodiment of the shielded containment system, a thermometer or radiation sensor is used to measure radiation levels from the containment vessel, which helps determine whether a supplemental radiation shield is necessary.

[0062] In operation, when a hazardous object, such as an explosive device, is located, a shielded containment system is moved to the location of the hazardous object. The door is then moved toward the open position and the hazardous object is inserted into the interior area. In some embodiments, robots, operators, conveyor belts, forklifts, and other product moving devices are also or alternatively used to move hazardous objects into the interior area. Once the hazardous object is positioned in the interior area, an operator moves the door toward the closed position to isolate the hazardous object. In an embodiment having latches, the latch is also moved toward a locked position to secure the door in the closed position.

[0063] Once a hazardous object is loaded into the interior area and the door is in the closed position, the containment system is moved to a remote location for safe disposal, storage or inspection. If a hazardous object explodes, leaks, releases harmful agents or materials, or releases radiation while sealed in the interior area, the radiation shielding system and optional supplemental radiation shield contain the harmful agents or materials in the interior area and prevent these harmful agents or materials from escaping to the atmosphere and causing harm to the operator or other people or animals in the area. The outer wall of the containment vessel, the door, and/or the radiation shielding system all help contain the explosion blast.

[0064] It should be readily apparent to those of skill in the art that in further embodiments of the radiation shielding panels described above, any number of panels may be used to form the radiation shield (e.g., as few as one or two panels to more than 15), the panels may have other configurations or shapes than those shown in the figures, and the panels may be oriented in other directions (e.g., vertically).

[0065] Various features and advantages of the invention are set forth in the following claims.